AIRCRAFT ACCIDENT

Air New Zealand
McDonnell-Douglas DC10-30 ZK-NZP
Ross Island, Antarctica
28 November 1979

REPORT 79-139

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AIR NEW ZEALAND

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OFFICE OF AIR ACCIDENTS INVESTIGATION
MINISTRY OF TRANSPORT
WELLINGTON

The Minister of Transport

SIR

The attached report summarises an investigation made into the circumstances of an accident involving McDonnell-Douglas DC 10-30 aircraft ZK-NZP on Ross Island, Antarctica, on 28 November 1979 in which the 20 crew and 237 passengers lost their lives.

This report is submitted pursuant to regulation 16(1) of the Civil Aviation (Accident Investigation) Regulations 1978.

R. CHIPPENDALE
Chief Inspector of Air Accidents

31 May 1980

APPROVED FOR RELEASE AS A PUBLIC DOCUMENT

COLIN McLACHLAN
Minister of Transport

12 June 1980

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OFFICE OF AIR ACCIDENTS INVESTIGATION
MINISTRY OF TRANSPORT
WELLINGTON
NEW ZEALAND

AIRCRAFT ACCIDENT
REPORT No. 79-139

McDONNELL-DOUGLAS DC 10-30 ZK-NZP
Ross Island, Antarctica
28 November 1979

BASIC INFORMATION

Operator: Air New Zealand Limited

Aircraft:
- Type: McDonnell-Douglas DC 10
- Model: Series 30
- Nationality: New Zealand
- Registration: ZK-NZP

Place of Accident: Ross Island, Antarctica

Date of Accident: 28 November 1979

SYNOPSIS

The occurrence of this accident was notified to the Chief Inspector of Air Accidents by Air New Zealand Limited at 2050 hours New Zealand Daylight Time[1] on 28 November 1979.

The State of Manufacture of the airframe and engines (United States) was advised of the accident on that day and invited to participate in the investigation. An accredited representative, who was a member of the National Transportation Safety Board, was appointed by the US and he was accompanied by representatives of the Federal Aviation Administration, McDonnell-Douglas Corporation and General Electric Company. The investigation was conducted by the New Zealand Office of Air Accidents Investigation.

At 0049:50 hours Greenwich Mean Time (Z) the aircraft collided with the ice-covered slopes of the northern side of Ross Island while it was inbound and 1 ½ miles east of its flight-planned track for its next turning point, Williams Field, McMurdo. The aircraft was flying toward a uniform snow covered ice slope which was beneath an 8/8 cloud cover. ZK-NZP was operating as a non-scheduled, domestic air transport flight from Auckland to Christchurch via various southern islands and the most southerly turning point, Williams Field. There were 20 crew and 237 passengers on board none of whom survived the accident.

[1] (Z + 13 hours)

1. FACTUAL INFORMATION

1.1 History of the Flight

1.1.1 In preparation for Flight TE 901 two of the pilots attended a route qualification briefing. This briefing consisted of an audio visual presentation, a review of a printed briefing sheet and a subsequent 45 minute flight in a DC 10 flight simulator for each pilot to familiarise him with the grid navigation procedures applicable to the portion of the flight south of 60° south latitude and the visual meteorological conditions (VMC) letdown procedure at McMurdo.[2] This briefing was completed 19 days prior to the scheduled departure date. The briefing gave details of the instrument flight rules (IFR) route to McMurdo which passed almost directly over Mt Erebus, a 12450 ft high active volcano, some 20 nm prior to the most southerly turning point, Williams Field. It also stated that the minimum instrument meteorological conditions (IMC) altitude was 16000 ft and the minimum altitude after passing overhead McMurdo was 6000 ft providing conditions were better than certain specified minima well in excess of the standard VMC in New Zealand. On the day of the flight the crew participated in a normal pre-flight dispatch planning.

1.1.2 At 1917 hours (Z) on 27 November 1979 Air New Zealand Flight TE 901, a DC10-30 (ZK-NZP) departed from Auckland Airport on a non-scheduled domestic scenic flight which was planned to proceed via South Island New Zealand, Auckland Islands, Baleny Island, and Cape Hallett to McMurdo, Antarctica then returning via Cape Hallett and Campbell Island to Christchurch its first intended landing point. The flight was dispatched on an IFR computer stored flight plan route. The flight deck crew consisted of the captain, two first officers and two flight engineers. Beside the fifteen cabin crew there was an official flight commentator on the flight who was experienced in Antarctic exploration.

1.1.3 The passenger load was reduced by 21 from the normal passenger seating capacity as a deliberate policy to facilitate movement about the cabin to allow passengers to view the Antarctic scenery.

1.1.4 In a discussion with the McMurdo meteorological office at 0018 hours (Z) the aircraft crew was advised that Ross Island was under a low overcast with a base of 2000 ft and with some light snow and a visibility of 40 miles and clear areas approximately 75 to 100 nm northwest of McMurdo. At approximately 0043 hours (Z) Scott Base advised the aircraft that the dry valley area was clear and that area would be a better prospect for sightseeing than Ross Island. In response to the message that the area over the Wright and Taylor Valleys was clear the captain asked the commentator if he could guide them over that way. The commentator said that would be no trouble and asked if the captain wished to head for that area at the time. The captain replied he "would prefer here first".

1.1.5 The US Navy Air Traffic Control Centre (ATCC) "Mac Centre"[3] suggested that the aircraft crew take advantage of the surveillance radar to let down to 1500 feet during the aircraft's approach to McMurdo and the crew indicated their acceptance of this offer. In the event however the aircraft was not located by the radar equipment prior to initiating its descent (or at any other time). The aircraft crew also experienced difficulty in their attempts to make contact on the very high frequency (VHF) radio telephone (R/T)and the distance measuring equipment (DME) did not lock onto the McMurdo Tactical Air Navigation System (TACAN) for any useful period. The aircraft was relying primarily on high frequency (HF) R/T during the latter part of its flight for communication with the ATCC.

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[2] The simulator instructor impersonated the Williams Field GCA operator and vectored the aircraft into position for this simulated letdown.

[3] The commonly used abbreviation for the official call sign of "McMurdo Centre".

1.1.6 The area which was approved by the operator for VMC descents below 16000 feet was obscured by cloud while ZK-NZP was approaching the area, and the crew elected to descend in a clear area to the north[4] of Ross Island in two descending orbits the first to the right and the second to the left. Although they requested and were granted a clearance from "Mac Centre" to descend from 10000 to 2000 feet VMC, on a heading of 180 grid (013°T) and proceed "visually" to McMurdo, the aircraft only descended to 8600 feet before it completed a 180° left turn to 375°G (190°T) during which it descended to 5,700 feet. The aircraft's descent was then continued to 1500 feet on the flight planned track back toward Ross Island.

1.1.7 Shortly after the completion of the final descent the aircraft collided with Ross Island. The aircraft's ground proximity warning system (GWPS) operated correctly prior to impact and the crew responded to this equipment's warning by the engineer calling off two heights above ground level, 500 and 400 feet, and the captain calling for "go round power". The aircraft's 3 engines were at a high power setting and the aircraft had rotated upwards in pitch immediately prior to impact.

1.1.8 The aircraft collided with an ice slope on Ross Island and immediately started to break up. A fire was initiated on impact and a persistent fire raged in the fuselage cabin area after that section came to rest.

1.1.9 The accident occurred in daylight at 0050 hours (Z) at a position of 77°25'30" S and 167°27'30" E and at an elevation of 1467 feet AMSL.

1.1.10 The cockpit voice recorder (CVR) and digital flight data recorder (DFDR) established that the aircraft was operating satisfactorily and the crew were not incapacitated prior to the accident.

1.2 Injuries to persons

1.2.1

Injuries	Crew	Passengers	Other
Fatal	20	237	0
Serious	0	0	0
Minor/None	0	0	0

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed by the impact forces and the post impact fire.

1.4 Other damage

1.4.1 The aircraft wreckage which was scattered over the ice slope constituted a temporary area of ecological pollution which was expected to be essentially neutralised by the progressive burial of the debris in ice and snow.

1.5 Personnel information

[4] All references to direction are related to true north unless otherwise specified.

1.5.1 Pilot in command, Thomas James Collins, held Airline Transport Pilot Licence No. 251 which was re-issued on 24 May 1979 to be valid until 30 April 1980. His type rating on the DC 10 aircraft was issued 26 August 1973. He held a current instrument rating and had held a flight navigator's licence, but this lapsed on 17 May 1971 (due to lack of opportunity for flying time as a navigator in the preceding 12 month period). He had a total flying time of 11151 hours and 2872 hours on DC 10 aircraft with a total of 140.35 hours in the last 90 days all on the DC 10 aircraft. He had last been rostered for duty on 22 November 1979 and last flew on 23 November 1979. He was well rested and had no recent illness or known significant worries prior to the flight.

1.5.2 The first officer who was in the right hand seat for the approach and descent to the accident site was Gregory Mark Cassin, who held Airlime Transport Pilot Licence No. 649 re-issued on 18 October 1979 and valid until 31 January 1977. He had a total flying time of 7934 hours and 1361 hours on DC 10 aircraft with a total of 127 hours in the last 90 days all on DC 10 aircraft. He was last rostered for duty on 20 November 1979.

1.5.3 The flight engineers changed shift during the final descent.

1.5.4 The flight engineer on the panel at the time of the accident was Gordon Barrett Brooks who had a total flying time of 10886 hours and 3000 hours on DC 10 aircraft with a total of 113 hours in the last 90 days all on DC 10 aircraft. He had a valid type rating on DC 10 aircraft issued on 11 February 1973 and qualified as a flight engineer on 4 December 1957. He was last rostered for duty on 26 November 1979 and had completed a previous Antarctic flight.

1.5.5 The flight engineer who relinquished the panel during the descent (but remained on the flight deck) was Nicholas John Moloney who had a total flying time of 6468 hours and 1700 hours on DC 10 aircraft with a total of 69 hours in the last 90 days all on DC 10 aircraft. He had a valid type rating on DC 10 aircraft issued on 9 February 1976 and qualified as a flight engineer on 10 July 1967. He was last rostered for duty on 11 November 1979.

1.5.6 The other first officer Graham Neville Lucas was not on the flight deck for any of the period during the descent from the cruising flight level to the accident site.

1.5.7 The cabin crew were all duly qualified and certificated, as enumerated in Annex A.

1.6 Aircraft information

1.6.1 ZK-NZP was a McDonnell-Douglas DC 10-30 aircraft. Serial No. 46910 with a construction date of November 1974. It was imported into New Zealand on 14 December 1974 for service with Air New Zealand Limited and allocated the registration letters ZK-NZP. The Certificate of Registration (MOT 1307) was issued to Air New Zealand Limited on 12 December 1974. The Certificate of Airworthiness issued on 30 December 1974 was subsequently re-issued on 8 May 1975 and was "non-terminating unless cancelled or suspended provided that the aircraft was maintained in accordance with the Air New Zealand approved maintenance manual". The last Maintenance Release was issued on 2 November 1979 following completion of Check A and was valid for 450 flight hours. The aircraft had completed 350 hours since the issue of the last Maintenance Release.

1.6.2 Three General Electric CF6-50C engines were fitted. The No. 1 (left) engine was serial no. 455158 with 18842 hours and 4580 cycles since new and 4874 hours and 1099 cycles since the last basic shop visit; the No. 2 (tail) engine was serial no. 517267 with 6345 hours and 1404 cycles since new and 350 hours and 83 cycles since its last basic shop visit; the No. 3 (right) engine was serial no. 455412 with 16181 hours and 3951 cycles since new and 5621 hours and 1226 cycles since its last basic shop visit (6500 hours or 1500 cycles are authorised between basic shop visits).

1.6.3 The aircraft had completed 20763 flying hours since new, 3283 hours since its last Check "C" and 350 hours since the last "A" check. (The approved flying hours between "A" checks and "C" checks are 450 and 4250 respectively).

1.6.4 An examination of the aircraft's maintenance documentation confirmed that the aircraft had been maintained in accordance with an approved maintenance manual. All significant defects had been investigated and rectified prior to the accident and all applicable Civil Airworthiness Requirements (CAR) had been complied with as required.

1.6.5 The aircraft was flying with 10 maintenance concessions issued by the company under the terms and conditions of their Civil Aviation Division (CAD) approval. These concerned, a small section of vent panel trim, a "Hi Lock" fastener head missing from the centre box section of the lower forward spar cap, a temporary repair to a wing-to-fuselage fillet panel, a wire adrift from the right-hand windshield anti-ice suppressor, 3 small holes in a fire seal channel on number 3 engine, a trial period of an unmodified generator control unit, sheared rivets in saddle tank rub strip, a damaged forward drain mast, a temporary repair to an access panel and damage to a wall trim panel.

1.6.6 The aircraft's estimated all up weight was 199150 kg and the centre of gravity (CG) 22.5% of the mean aerodynamic chord (MAC) at the time of the accident. The maximum take off weight authorised was 253105 kg (actual 246507) and the CG limits at 199000 kg are 11% to 29% MAC.

1.6.7 The fuel in use was Jet A1. (Specific gravity at 15° was 0.804).

1.7 Meteorological information

1.7.1 General Situation. On 28 November 1979 at 0100 hours (Z) the McMurdo area was under the influence of a surface low pressure trough extending from the Queen Maud mountains to the Ross Sea. Observations in the area reported a total cloud cover with a base of 3500 feet with layers above. The wind at McMurdo was 230° Grid at 10 knots. Although local effects in the area of the accident site near Mt Erebus could have caused gusty turbulent conditions with stronger winds, the aircraft's navigation computer unit (NCU) memory recorded a wind of 138°/12 knots at the time of impact. The surface visibility was good but the Antarctic procedure used to report surface and horizon definition (see Annex B) gave the surface definition at the time as poor and the horizon definition fair. Mountain tops in the area were covered in cloud.

1.7.2 Local aircraft reports :

a. A United States Navy (USN) C-130 aircraft was inbound and 80 miles from McMurdo at 0100 hours (Z). The crew described the meteorological conditions at 0100 hours (Z) as follows: "At 80 miles out and approaching from the west-north-west (the crew) observed a continuous stratoform layer covering Ross Island with cloud "domes" over Mt Erebus and Mt Terror which concealed the mountains from view. The cloud layer extended to the north of Ross Island. A lenticular "cap cloud" was over Mt Erebus above the main cloud layer." The aircraft descended into cloud at approximately 16000 feet and remained in variable cloud densities, except for one break of about 1500 feet vertically, until it descended through 2500 feet. The lowest layer was solid overcast with a ragged base. The visibility was good below the cloud base but the surface definition was poor. The aircraft encountered light turbulence during the descent but no evidence of icing and landed at McMurdo's ice runway at 0120 hours (Z).

b. At 0105 hours (Z) a helicopter flying over the slopes of Mt Erebus above Cape Royds attempted to ascend over the saddle between Mt Erebus and Mr Bird. The cloud base was above the saddle but the pilot turned back due to the poor surface definition in the area and decided to enter Lewis Bay via Cape Bird. The aircraft landed at Cape Bird hut at 0140 hours (Z) where the weather was overcast with a southerly wind and light snow. The helicopter later took off and flew around Cape Bird at 1500 feet and was below the cloud base all the way. At 0200 hours (Z) it landed on the beach 10 km from the accident site and the conditions at that time were overcast with light snow but the sun could be "made out" through the cloud occasionally. The surface definition at the time was very poor to nil.

The aircraft encountered no turbulence on the approach into a light north west wind for landing. The aircraft remained on the ice for 50 minutes during which time the sky continued overcast and the visibility was decreasing due to snow flurries. Beaufort Island could be distinguished to the north but was not clearly defined. Due to the deteriorating weather the crew decided to cut their visit short. They were not able to distinguish that the slopes to the south were elevated or separately identify cloud and snow. No bare rock was visible on the slopes but the rocky coastline below the ice cliffs was visible. The aircraft returned to Bird hut and the crew found weather conditions much the same as they were when they had departed.

c. A United States Air Force (USAF) C-141 aircraft was following some 45 minutes behind Air New Zealand Flight TE 901. The captain of this flight made the following comments about the weather:

"As we approached McMurdo we noted that Ross Island was obscured by cloud; no terrain was visible. We displaced our flight path to the west approximately 25 miles to allow a gradual, long-range descent over the water At the time we were navigating entirely by INS (inertial navigation system). We maintained 1600 feet until McMurdo picked us up on radar; as I remember, this was at about 38 miles. We began descent and entered the clouds immediately. The cloud cover appeared to be ordinary cumulus or stratocumulus. We encountered only light rime icing and light turbulence during descent. Between approximately 12500 and 11000 feel we passed between cloud layers. Visibility seemed good between clouds but no terrain was visible. We broke out of the cloud base at about 5000 feet; visibility beneath the ceiling was good. We landed at McMurdo at 0152 hours (Z) on 28 November."

1.7.3 At 0010 hours (Z) "Mac Centre" broadcast the following actual weather conditions experienced at 0001 hours (Z) on the Ice Runway "2000 overcast, visibility 40, temperature minus 4 Celsius, gridwind 200 at 20, altimeter 2930, surface fair, horizon fair".

1.7.4 At 0018 hours (Z) the forecaster at McMurdo spoke directly to the crew of TE 901 and advised the following "We have a low overcast in the area at about 2000 feet and right now we are having some light snow but our visibility is still about 40 miles. It looks like the clear areas around McMurdo are approximately between 75 and 100 miles to the northwest of us but right over McMurdo we have a pretty extensive low overcast".

1.7.5 The forecast for the McMurdo area given to crew of flight TE 901 at their pre-flight briefing was:

"McMurdo 270300-280300Z. Cloud base 3000 feet broken, variable to overcast, visibility 40 miles surface wind (Grid) 310°/10 kts, occasional 3000 ft overcast, visibility 5 miles in light snow. Information from weather analysis. Much cloud with large occlusion 70°S and 150°W, Byrd (Station) to South Pole. Much ridge type cloud probable, base about 3000 feet."

1.7.6 At 1943 and 2030 hours (Z) Auckland Radio passed the actual weather conditions at McMurdo to Flight TE 901 for 1900 and 2000 hours (Z) respectively. These were:

"McMurdo at 2000 estimated 8000 broken, 10000 broken. Visibility 40 miles. Temperature minus 6. Wind Grid 200°/10. Altimeter 2938. Surface definition fair; horizon definition good".

1.7.7 At 2153 hours (Z) Auckland Radio passed a new terminal forecast for McMurdo to Flight TE 901 as follows:

"Terminal forecast McMurdo valid from 272100 and it's valid until 282100. 4000 broken, 10000 broken. Visibility 40 miles. Wind Grid 220°/10 knots gusting 18 knots. The sky conditions broken variable scattered occasionally 4000 broken visibility 5 miles light snow QNH 2930".

1.8 Aids to navigation

1.8.1 The ground navigation aids available[5] to the aircraft's crew were limited to a medium frequency non-directional beacon 506 kHz (NDB) a TACAN installation suitable for interrogation by the aircraft's distance measuring equipment (DME) and a radar installation (AN/FPN 36 QUAD) which provided airport surveillance radar (ASR), precision approach radar (PAR), and an "AIMS" Mark 12 IFF system.

1.8.2 These aids were approved "for use by Antarctic Support Deep Freeze aircraft but were available to other operators for use at their own risk".

1.8.3 The Radar, NDB and TACAN were calibrated by local military aircraft to FAA standards and monitored by reports from the Operation Deep Freeze (ODF) aircraft which used them regularly.

1.8.4 Promulgation of radio navigation information at McMurdo was the responsibility of the United States navy who installed, calibrated and maintained all aids in accordance with the United States Standard Terminal Instrument Procedures Manual (TERPS). This manual was standard for the FAA, USAF, USN, US Army and the US Coast Guard. However, because of the special nature of the operations in Antarctica the aids and ATC procedures were installed specifically for the Antarctic Support, Operation Deep Freeze (ODF), aircraft. Every approach chart and letdown procedure and radio navigation chart carried specific cautions to warn of:

a. Incomplete survey data making en-route minimum altitudes unreliable.
b. Radio and radar altimeters erratic over snow.
c. Promulgated procedures are intended for use by Operation Deep Freeze aircraft only, others may use at their own risk.

1.8.5 The Air New Zealand crew was briefed that the NDB facility had been withdrawn as the result of advice from CAD to this effect but the beacon was transmitting on a 24 hour basis as the USN had decided to leave it transmitting and not to dismantle it until it failed.

1.8.6 The aircraft was fitted with an area inertial navigation system (AINS) which facilitated worldwide navigation based on radio and inertial data. The system provided data and information to navigate the aircraft on area navigation routes or great circle tracks from take-off to the final approach.

[5] In this context "available" as it refers to the M/F NDB means operating and able to be received by the aircraft equipment.

1.8.7 All the navigation aids were operating normally for the duration of the final approach of ZK-NZP, towards McMurdo, but the aircraft's DME did not lock onto the TACAN for more than one short period, the aircraft was not seen on the surveillance radar and its transponder was not detected by the radar equipment. The controls for the aircraft's transponder when retrieved from the wreckage were set to the correct code but switched to "standby".

1.8.8 The aircraft's low altitude approach placed the Mt Erebus volcano in the line of sight between these aids and the aircraft.

1.8.9 The aircraft was equipped with a Bendix RDR 1F radar which had a digital indication. This equipment has both "weather" and "mapping" modes. Although it is not approved as a navigation aid, some pilots of previous Antarctic lights reported that the radar indications of high ground correlated well with the contours which they observed visually in VMC. Expert opinion from the aircraft manufacturers was that the high ground on Ross Island would have been clearly indicated by the "shadow effect" had either pilot studied the radar presentation during the aircraft's descent to the north of the island.

1.9 Communications

1.9.1 The crew spend a considerable time endeavouring to establish a reliable communications link with "Ice Tower" and "Ice Radar" during the last 30 minutes of the aircraft's flight towards their McMurdo waypoint (the McMurdo TACAN). Three VHF frequencies were tried by the aircraft's crew 134.1 (GCA); 126.2 (Tower) and 121.5 MHz (Guard). None of these proved a reliable communications link but an occasional contact was made on 134.1 and 126.2 MHz.

1.9.2 The HF R/T link remained satisfactory between McMurdo and the aircraft. The last exchange of transmissions occurring 4 minutes 42 seconds before the accident happened.

1.9.3 As with the navigation aids the aircraft was not positioned in a line of sight with the appropriate VHF transmitters during most of the last phase of the flight.

1.10 Aerodrome information

1.10.1 Not applicable.

1.11 Flight recorders

1.11.1 Cockpit Voice Recorder. The aircraft was equipped with a Sundstrand Model B CVR Serial No. 256 Part No. 980-6005-061. A useful record was eventually obtained from the tape in the CVR but the task was made unusually difficult by the presence of the extra persons on the flight deck namely the second flight engineer, the commentator and passengers who were invited there by the captain to add interest to the flight for them.

1.11.2 The essential items of the recording from the cockpit area microphone (CAM) were almost all recovered by the joint efforts of teams in the United States and United Kingdom operating in the sound laboratories of the NTSB and the Federal Bureau of Investigation (FBI) in the USA and the Accident Investigation Branch (AIB) in the UK. The manufacturers of the CVR also aided by providing a 4 track recording of the original 8 track tape to assist these laboratories. The resultant transcript of the relevant portions of the CVR tape is attached as Annex C.

1.11.3 Digital Flight Data Recorder. The aircraft was equipped with a Sundstrand Model DFDR Part Number 981-6005-012 serial number 2484. The DFDR was not seriously damaged in the accident but the tape was broken on impact. The equipment performed satisfactorily and all the parameters had been recorded correctly. All of the record required for the investigation was recovered.

1.11.4 The DFDR record showed that the aircraft carried out 2 descending orbits, one either side of the flight plan track in the Lewis Bay area then continued toward McMurdo on this track while descending from 5800 feet to 2000 feet, initially, before finally levelling out at 1500 feet above mean sea level (AMSL). The flight from this point was straight and level with a 5° nose up attitude at 260 knots indicated air speed (IAS) until the last data sampling immediately before the impact when the aircraft rotated in pitch to approximately 10° nose up and number 1engine had "spooled up" to 94% just prior to the impact. The DFDR records each engine's N_2 rpm once every four seconds and number 1 engine's rpm was the last to be recorded prior to impact.

1.11.5 The detail of the DFDR readout and a narrative correlation of the CVR and DFDR are given as Annex D to this report.

1.12 Wreckage and impact information

1.12.1 The entire wreckage site was surveyed by a Lands and Survey Department Surveyor and an assistant from the Ministry of Works and Development. The team surveyed and marked a grid of 30m squares over the complete wreckage train and a 30m buffer zone around this area. They also plotted the position of each victim's remains and surveyed the profile of the terrain from sea level to the impact site.

1.12.2 The collision of the aircraft with the ice covered slope left a clear impression of the fuselage, wing mounted engines and flap hinges in this ice which showed that ZK-NZP was in a wings-level, nose-high attitude when the impact occurred.

1.12.3 The wreckage trail was typical of a high speed impact and resulted in extensive fragmentation of the underside of the wing and fuselage. The wing engines were stopped immediately after impact by the distortion resulting from the impact with the ice.

1.12.4 The 2 wing mounted engines, the underside of the wings and the bottom of the rear fuselage bore the main impact of the collision and some debris from each of these areas was evident in the impact crater.

1.12.5 Immediately following the initial impact the aircraft lofted over the mound of ice and snow displaced by from the impact area and flew up the 13° ice slope in a wings level attitude. Extensive destruction which continued until the wreckage came to rest would have been accentuated by an air pressure differential of approximately plus 1.1 psi between the interior of the fuselage and the outside environment.

1.12.6 The number 2 engine mounted in the tail fin, continued to deliver considerable power after the impact.

1.12.7 The integrity of the fuselage was broached early in the breakup sequence and the majority of the victims were ejected before the last of the wreckage came to rest. Most of the remainder were thrown clear by the final impact.

1.12.8 The spread of the wreckage covered a total area which was some 570m by 120m and was aligned on a bearing of 357° Grid (190° true). The wreckage area's uphill slope from the point of impact was 13° with a 5° cross slope, downhill from right to left. The accident site was located on the top of a solid layer of ice which had a light covering of dry powder snow. Two deep crevasses crossed the area of the main wreckage trail but much of the lighter debris was moved onto an adjacent, extensively crevassed area by subsequent storms and was not recovered.

1.12.9 Although the aircraft had increased its nose up pitch attitude and its engines' power was increasing immediately prior to impact, its flight path was essentially straight and level when it collided with the slope.

1.12.10 The largest portion of the aircraft remaining was the complete constant section length of the damaged cabin section which remained attached to the wing's centre and inboard sections. This portion was at the forward end of the wreckage train an was involved in a persistent, intense and deep seated fire.

1.12.11 The upper forward fuselage section which contained the front galley and flight deck came to rest short of and to the left (east) of the main fuselage section and although it was extensively damaged it was not involved in any fire.

1.12.12 The entire length of the wreckage trail, was impregnated with aviation turbine fuel and covered with soot.

1.12.13 The aircraft was in the normal configuration for cruising flight with the undercarriage and flaps and slats up. The horizontal stabiliser jack screws, indicated a nose up trim of 2° was applied at the time of impact.

1.12.14 A diagram of the wreckage distribution at the accident site is attached as Annex E.

1.13 Medical and pathological information

1.13.1 All of the aircraft's occupants who were recovered were killed by the injuries sustained as a result of the deceleration of the aircraft.

1.13.2 A review of the flight crew's medical records disclosed no evidence of pre-existing physical problems which could have affected their judgement or performance. The post-mortem and toxicological investigations did not reveal any abnormalities in any flight deck crew member.

1.13.3 An extensive effort resulted in most of the victims being recovered. Of these 213 were identified. All those recovered were subjected to a post-mortem examination in Auckland which established there was no suspicion of any cause factor related to the passengers or cabin crew.

1.13.4 A detailed review of the location of the victims who were recovered from the wreckage site was compared with the allocated seating plan as was the nature of the injuries sustained by each occupant.

1.13.5 The post-mortem examinations indicated that all the victims were killed by the injuries received at the initial impact rather than as a result of burns sustained in the subsequent fire.

1.14 Fire

1.14.1 The evidence in the wreckage trail indicated that a fire was ignited immediately after the impact and that a persistent fire raged in the centre section of the fuselage but aft of the front galley. The residual fuel in the left wing ranks which were the only fuel tanks to retain their essential integrity probably sustained this conflagration. The source of ignition was not determined.

1.14.2 The fire did not involve the fuselage interior immediately after impact and many of the victims showed no evidence of being burnt.

1.14.3 The fire burnt itself out before the wreckage was located therefore no fire fighting equipment was involved.

1.15 Survival aspects

1.15.1 The accident was unsurvivable. All of the injuries sustained indicated a deceleration at impact, that could not be survived with the type of restraint provided by a seat belt, additionally very few occupants appeared to have been wearing these seat belts.

1.15.2 The aircraft's survival equipment had not been modified or supplemented to cater for survival in the cold land or cold sea environment of the Antarctic. No training had been given to the flight or cabin crew members on Antarctic survival techniques and no adaptation of the standard emergency briefing to the passengers was planned. The CAD Airline Inspector who attended this cabin crew's pre-flight briefing was critical of this aspect and handed the Chief Purser a copy of some cold weather survival notes to study to enable him to brief his cabin crew on cold weather survival techniques during the course of the flight.

1.16 Tests and research

1.16.1 A report was received from an Air New Zealand pilot that on occasions additional waypoints fed into another Air New Zealand DC 10 aircraft's navigation computer at a later stage had "dropped out" without warning.

1.16.2 It was confirmed that several instances of waypoints "dropping out" had occurred. This resulted in an incorrect indication that a point had been passed before the aircraft actually arrived at the position. This malfunction was unlikely to occur when the system was using latitude and longitude positions and operating in the "inertial" mode as in this case because any additional waypoint would have to be inserted using latitude and longitude in the same way as the flight planned waypoints and there is no reason to believe one latitude/longitude waypoint would drop out without the others also disappearing.

1.16.3 The performance of the GPWS was evaluated and it was assessed that the warning was in accordance with the expected performance in the "terrain closure" and "flight below 500 feet without flaps and undercarriage extended" modes of the equipment (modes 2A and 4 respectively). The profile of the terrain prior to the impact was reconstructed in Air New Zealand's DC 10 simulator and the performance of the aircraft was evaluated to determine if the collision could have been avoided in response to the warning and that the warning was in fact given at the maximum time before impact that could be expected.

1.16.4 The flights in the simulator indicated that experienced pilots would not have avoided a collision and that the warning given was in accordance with the design specifications of the GPWS. With sufficient rehearsal it was possible to fly the aircraft away from the approaching slope when an extreme manoeuvre was initiated in response to the onset of the GPWS warning.

1.17 Additional Information

1.17.1 Route briefing. Two of the 3 pilots of the operating crew of flight TE 901 were subjected to the specially devised audio-visual, written and simulator route qualification briefing for the route to and from Antarctica (First Officer Lucas had not received the Antarctic route briefing). The navigation procedures to be used (particularly the use of grid navigation) the radio frequency chart indicating the probable best HF frequencies for the time of day and certain company policy matters in relation to the entertainment and welfare of passengers on the flight were all detailed.

1.17.2 An examination of this briefing revealed certain significant items were not included:

a. The authority of the US Navy's Antarctic ATC system to control the civilian Air New Zealand flight.

b. The procedure for determining the minimum flight level recognised for the Antarctic area and specifically the McMurdo control area.

c. The way in which the Air New Zealand route varied from the normal military route, which followed the reporting points depicted on the Radio Navigation Chart (RNC), (see Annex F) particularly on the leg from Cape Hallett south to McMurdo.

d. Topographical maps for use on the flight. With the exception of a Photostat copy of a small insert enlargement of a map of Ross Island (1:1,000,000), these were not issued to the crew until the day of the flight, and were of a relatively small scale i.e. 1:5,000,000 and 1:3,000,000.

e. A comprehensive discussion of the visual phenomenon peculiar to the Antarctic, i.e. the whiteout conditions, which might be anticipated with overcast sky and snow covered terrain below. (Refer paragraphs 1.17.46-58 inclusive).

f. A discussion of the procedure for attempting a landing on the local ice runway or skiways and the emergency conditions which might necessitate such a landing.

g. The most effective methods of attempting to achieve survival on the ice (with the equipment available) in the event of a successful forced landing.

h. The fact that the medium frequency NDB was still operating.

1.17.3 The original requirement for radar monitoring of any VMC letdown was deleted by the letter of amendment detailing the conditions for VMC letdowns which were to apply following the withdrawal of the NDB letdown procedure. The revised version called only for the descent to be co-ordinated with local radar control.

1.17.4 Although topographical charts for the area were available on the day of the flight the only "charts" of the area below the flight planned track from Cape Hallett to McMurdo available at the initial briefing were:

The passenger information map
(an overprint on a 1:16,000.000 chart) (Annex G)
The RNC chart (Annex F) and
A slide depicting a schematic diagram taken from the rear of a passenger brochure (Annex H)

All of which showed a track proceeding o the true west of Mt Erebus down the McMurdo Sound. While these "charts" were not intended to be used for navigation the track shown was not that to be followed by TE 901. Several members of earlier crews were of the opinion that the inbound track to McMurdo was intended to be on an alignment which was over the sea level ice to a point adjacent to McMurdo but to the west of that base. (The dialogue which accompanied the audio visual briefing referred to the RNC chart when discussing the appropriate flight levels for the flight.)

1.17.5 The strip map of the route from Christchurch to McMurdo (Annex I) issued on the day of the flight also had two tracks printed on it both depicting a passage to the west of Ross Island. A track and distance diagram (Annex J) issued at the route qualification briefing correctly depicted the intended flight plan track from Cape Hallett to the McMurdo TACAN, but this showed no relationship to geographical location or terrain.

1.17.6 The audio visual presentation of the route qualification briefing showed two slides purporting to be of the track between Cape Hallett and the McMurdo TACAN. The first which only showed Cape Adare, 73 miles northwest of the Cape Hallett waypoint, accompanies the statement "We are almost 77° south proceeding from Cape Hallett towards Ross Island at Flight Level 330. Mt Erebus, almost 13000 feet, ahead. McMurdo Station and Scott Base lie 20 miles beyond the mountain in the direction of grid north". A second slide accompanies the statement "Now approaching Erebus at 16000 feet the minimum sector altitude. In VMC a descent to this minimum altitude up to 50 miles before McMurdo will be found advantageous for viewing". This slide gave no indication of the relationship of the track to Mt Erebus, as it shows a view of Mt Erebus taken from behind the co-pilot's seat with the aircraft heading north.

1.17.7 The computer flight plan used at the briefing had been in error for 14 months in that it showed the destination point for McMurdo as two degrees ten minutes of longitude to the west of the intended turning point. This error was not corrected in the computer until the day before the flight. Although it was intended that it be drawn to the attention of the previous crew, immediately prior to their departure this was not done, nor was it mentioned during the pre-flight dispatch planning for the crew of the accident flight. The crew was shown a copy of the erroneous flight plan with the incorrect co-ordinates at the route qualification briefing but the flight plan issued on the day of the flight was correct.

1.17.8 Mention was made in both the audio-visual presentation and the written brief of "A whiteout emergency landing area for ski-equipped aircraft" located grid northwest of and adjacent to Williams Field with a landing procedure and talk down being available from the PAR (Precision Approach Radar) Controller, Williams Field.

1.17.9 The United States Navy advised "The emergency whiteout landing area does not have PAR available. Its location is primarily to the grid west of the Williams Field Skiway complex, starting one mile from the TACAN on the 240° Grid radial; arcing grid north at one mile to the 330° grid radial then out on the 330° grid radial; then out the 300° grid radial to 15 miles then arcing south on the 15 mile arc to the 240° grid radial; then inbound on the 240° grid radial to the starting point, one mile from the TACAN." "This area along with the skiway, is for ski-equipped aircraft only. Wheel equipped aircraft would use this area only if a crash landing/ wheels up landing was required."

1.17.10 On 4 February 1977 a CAD Airline Inspector witnessed the briefing at ODF Headquarters, Christchurch of the pilots in command of the first two flights. On 15 February 1977 another Airline Inspector witnessed the pre-flight dispatch planning before the first flight. This second Airline Inspector also viewed the audio visual presentation portion of the route qualification briefing in October 1977 and again on 26 November 1979. On 28 November 1979 the second Airline Inspector witnessed the pre-flight briefing given by Air New Zealand's Chief Purser.

1.17.11 The loss of communication procedure given in the briefing notes was an abbreviated and reworded version of the full procedure and the reference given for the full procedure quoted a superseded page number of the particular document quoted. (One significant omission relevant to the Antarctic was the absence of any reference to adjustments to minimum safe altitudes to be made in the Antarctic when low barometric pressures exist. This applies to "lost comms" procedures as well as normal navigation).

1.17.12 To meet the operator's responsibility to have the pilot-in-command "demonstrate that he has an adequate knowledge of the route to be flown" (see paragraph 1.17.21), Air New Zealand Limited required the pilot-in-command of each flight to practise setting up the aircraft's instruments and navigation procedures for grid navigation and simulate a night[6] VMC letdown using the arcs and distances specified for the day VMC procedure at McMurdo.

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[6] The Air New Zealand DC 10 flight simulator's external presentation of terrain is limited to the night lighting of any aerodrome environment. Terrain is not simulated in any other way and the pilots undergoing training are briefed on the proximity of high ground by the simulator instructor.

1.17.13 The audio visual route qualification briefing stated that the "minimum sector altitude" or "company sector safe altitude" for approach to McMurdo was 16000 feet and that descents to the overall minimum of 6000 feet were only permitted in a sector to the true south of McMurdo in conditions of 20 km visibility or better and only then if there were no snow showers in the area and the descent was co-ordinated with the local radar controller. The written briefing notes emphasised the point thus "If VMC cannot be maintained FL 160 is the minimum safe altitude".

1.17.14 The company's briefing notes on the local McMurdo procedures had not been forwarded to the Air Traffic Control authorities at McMurdo and the Air Traffic Control staff there were not aware of the approved minimum altitudes, the VMC letdown sector approved or the conditions specified for VMC letdowns.

1.17.15 The company briefing specifically mentioned that passengers' visits to the flight deck should be firmly controlled and stressed that such visits should be limited during low-level operations.

1.17.16 The CAD had been discussing with the airline the desirability of carrying cold weather survival equipment on such flights but had not made CAD approval for these flights dependent upon the carriage of such equipment.

1.17.17 Operations specifications. The Air New Zealand Limited Operations Specifications which form part of their Air Service Certificate No. 22 specified as follows:

a. Page 61 (dated and effective 20 December 1977)

1. In accordance with subparagraph 2.12.1 of these Operations Specifications, route and aerodrome familiarisation training is required on those routes set out in the schedules forming part of (Appendix VI).

2. It shall be the responsibility of the pilot-in-command to ensure, before flight over any route, that he and the flight crew members under his command comply with the route and aerodrome qualifications required by Civil Aviation Regulation No. 79[7] and these Operations Specifications.

b. Page 62 (dated and effective 16 October 1978)

1. The area and aerodrome qualifications specified in the schedules to this appendix shall be deemed to comply with the regulation. A pilot who holds a valid area qualification in accordance with Schedule I will be qualified for flights on all routes within that area or between that area and any adjacent area for which he holds a valid area qualification, provided that he also holds valid aerodrome qualifications for the appropriate aerodromes and their alternates.

2. The Company shall maintain an approved record of the area and aerodrome qualifications of all its pilots.

3. Where the requirements specified in these schedules cannot be met the Director may approve an alternative means of compliance with the regulations.

4. Where the Company undertakes non-scheduled flights which are not of a continuing nature the Flight Operations Director shall ensure that sufficient route familiarisation training is provided to comply with Regulations 79[7].

5. The following schedules form part of this appendix:

[7] Regulation 79 became Regulation 77 with amendment 22 to Civil Aviation Regulations with effect from 12 February 1979 but the Operations Specifications had not been amended as at 28 November 1979.

Schedule IArea Qualification
Schedule IIAerodrome Qualification
Schedule IIISummary of Approved Aerodrome Qualification

c. Page 63 (dated and effective 20 September 1977) and Page 64 (dated 12 May 1978 and effective 17 May 1978)

1. **Designated Areas**
For the purpose of route familiarisation training the following geographic areas have been designated.

d. **Antarctic**
The Antarctic area shall cover flights within the area of compass unreliability south of the Antarctic Circle.

2. **Area Qualification Requirements**
Area qualification shall consist of the following:

a. A comprehensive pre-flight briefing which covers at least the following items:

(i) En-route and terminal routing
(ii) Terrain and minimum safe altitudes
(iii) The seasonal meteorological condition and statistics
(iv) Meteorological communication and ATC facilities, services and procedures
(v) Navigation facilities
(vi) Prohibited and restricted areas
(vii) Search and Rescue facilities and procedures
AND within 30 days

b. A flight in the area under the supervision of a person authorised by the Flight Operations Director.

3. **Period of Validity and Requalification**
An area qualification shall remain valid for a period of 12 months from the date of the flight qualification specified in 2(b) and shall be extended to 12 months from the date of each subsequent flight in that area, either as a crew member or as an observer on the flight deck of an approved air carrier.

Where more than 12 months have elapsed from the last flight in that area the comprehensive briefing and flight under supervision specified in 2(a) and (b) initial issue shall be required for requalification.

d. Page 65 (dated and effective 16 October 1978)

2. **Standard Aerodrome Qualification**
2.1 Standard aerodrome qualification shall consist of the following requirements for pilots in command.

(a) A comprehensive briefing which shall include:

(i) Seasonal meteorological conditions
(ii) Terrain and minimum safe altitudes
(iii) Approach aids and procedures
(iv) Prohibited and restricted areas

(v) Any special procedures including SIDs and STARs
(vi) Ground facilities
AND within 30 days
A flight into the aerodrome which may be completed as an observer on the flight deck of an air New Zealand or approved airline operators aircraft, **OR**

(b) An approved pictorial presentation for that aerodrome.

e. Page 70 (dated 12 May 1978 and effective 17 May 1978) which is the second page of Appendix VI Schedule III "Summary of Airport Qualification Requirements – Pilots-in-Command".

AIRPORTS	**Initial Qualification**	**Requalification after 12 months**	**Requalification after 24 months**
Antarctic			
McMurdo Sound	RCU and SIM	RCU	Initial Qualification

Note: Qualification applies only to cloud break procedure and approach – no landing requirement.

1.17.18 In a letter 98/4/4 of 6 December 1977 headed ROUTE QUALIFICATION REQUIREMENTS – OPERATIONAL SPECIFICATIONS to Air New Zealand Limited, the Director of Civil Aviation stated in part:

"Additionally, the slide presentation of the Antarctic has also been approved for familiarisation purposes."

1.17.19 None of the pilots on this flight had previous Antarctic experience but on 24 October 1979 a signal message from Air New Zealand Limited to CAD asked:

"OPS 880 Flight Operations. Reference our telecon regarding the operation of company flights to Antarctica and return non-stop it is our understanding that because of the briefing programme carried out in our route training unit and the simulator detail covering exercises in grid navigation and the NDB could break at McMurdo that there is no requirement for flight under supervision. The briefing and simulator detail are completed within the week prior to operating the flight[8]. Would you please confirm that our understanding is correct".

In a reply dated 24 October 1979 CAD stated:

"OPS 523 98/4/14. Your OPS 880 is confirmed correct and Ops Specs will be amended to reflect such detail".

1.17.20 While the CAD had not specified any specific minima for the flight their approval for the operation of the flights was subject to them being conducted in accordance with the criteria suggested by the company.

1.17.21 Civil Aviation Regulations paragraph 77(1)(a) and (b) states:

77. Route and aerodrome qualifications of pilot in command –

(1) A pilot shall not act as pilot in command of an aircraft engaged in an air transport operation on a particular route unless:

[8] The briefing for the pilots of this flight on 28 November was completed on 9 November 1979.

(a) he has demonstrated to the operator that he has an adequate knowledge of the route to be flown and the aerodromes which are to be used, including an adequate knowledge of:

(i) The terrain and minimum safe altitudes;
(ii) The seasonal meteorological conditions;
(iii) The meteorological, communication, air traffic facilities, services and procedures;
(iv) The search and rescue procedures; and
(v) The navigational facilities associated with the route along which the flight is to take place; and

(b) He has demonstrated to the operator that he has adequate knowledge of procedures applicable to flight paths over heavily populated areas of high traffic density, obstructions, physical layout, lighting, approach aids, and arrival, departure, holding and instrument approach procedures and applicable meteorological minima. Provided that any portion of the demonstration relating to arrival, departure, holding or instrument approach procedures may be accomplished in an aircraft flight simulator if specifically approved by the Director.

1.17.22 Approval for Antarctic flights. In June 1971 the Minister of Transport summarised the situation regarding proposals for Air New Zealand Limited to fly to Antarctica as follows:

"Officers of the Civil Aviation Division of the Ministry of Transport and of Air New Zealand have made a complete study of the possibility of operating to Antarctica. A joint team visited the area in November 1969 and on their recommendation it was decided to defer any further action in the meantime. This decision was brought about by a lack of passenger terminal accommodation facilities at McMurdo, ground transportation problems and operational requirements including fuel reserves. While the operation is technically possible it would impose such restrictions as to make it a very doubtful viable economic operation. The project has not been abandoned but, in view now of Air New Zealand's re-equipment programme, it has for the present been deferred".

1.17.23 Following the visit to Antarctica, of the joint team mentioned in the Minister's statement, the Director of Civil Aviation (DCA) had stipulated that if certain conditions could be met by Air New Zealand Limited flights to the Antarctic would be approved. These conditions stipulated in letter 98/4/76 of 19 December 1969 included:

"2 (d) Prior to commencing revenue earning operations a proving flight will be required unless the pilot-in-command has previous experience of operations at McMurdo Sound.

4. It will be (Air New Zealand's) responsibility to submit for approval a scale of protective clothing to be supplied for passengers and crew and a revision of the contents of the aircraft emergency pack for Antarctic weather conditions".

The remaining conditions applied specifically to operations involving the DC 8 aircraft and the approval was generally for DC 8 aircraft with a planned landing at McMurdo. However, no further familiarisation visits were made to Antarctica by either CAD or Air New Zealand Limited representatives.

1.17.24 Following Air New Zealand's re-equipment with DC 10-30 aircraft a proposal was made in December 1976 by Air New Zealand Limited that they be permitted to conduct flights from Auckland to Christchurch by way of Antarctica. (The operation differed from the previous DC 8 proposal in that no landing or descent below 16000 feet was planned in Antarctica and accordingly no flaps, slats or undercarriage extension was intended).

These were proposed as charter flights but in the event became non-scheduled domestic air transport flights. To support their request for the initial 2 flights Air New Zealand Limited submitted the details under the following headings (their letter HO:AC:13 of 24 December 1976);

Flight schedule
All up weight
Proposed route
Reserve fuel
Provision for a depressurisation emergency
Briefing of captains by Operation Deep Freeze Headquarters

In a letter of the same reference dated 18 January 1977, Air New Zealand Limited submitted amended details of Maximum Zero Fuel Weight; flight time; route and flight planning details.

1.17.25 The Director of Civil Aviation granted approval (98/4/76) dated 19 January 1977) for the two flights subject to Air New Zealand's compliance with detailed instructions on the following:

Route to be submitted in writing.
Communications procedures. Both normal and in the event of a communications blackout. To be submitted for inspection. Specification of navigation procedures below 70°S by the operator.

A briefing by Christchurch Air Traffic Control/Deep Freeze for the captain and co-pilot to be completed not less than three days prior to departure. (To be attended by an Airline Inspector from CAD to ensure Regulation 79(1)(a) (now Regulation 77) was complied with). An Airline Inspector to be carried as an observer on the first flight.

1.17.26 It was subsequently proposed by the operator and agreed by CAD that the briefing by Christchurch Air Traffic Control/Deep Freeze Headquarters would be attended by the captains of the 2 flights only and they would, in turn, brief their own crews.

1.17.27 On 2 February 1977 Air New Zealand Limited submitted a letter to meet the requirements of DCA letter of 19 January 1977. There is no record of any comment on this letter by DCA, but the first flight was utilised by an Airline Inspector to make a formal Air Transport Flight Inspection Report on form CA 1333. This report dated 15 February 1977 showed all items on the en route inspection check list to be satisfactory and the summary of the flight was: "Nil adverse comments. A well conducted flight in all respects". (See Annex K). This was the last recorded flight inspection. A further inspection was planned in 1979 but it did not eventuate.

1.17.28 On 10 August 1977 Air New Zealand letter HO:B:22 requested authority to conduct five flights overflying Antarctica in the McMurdo area undertaking to operate these flights to the specification earlier submitted with the following exceptions:

"a. A proposal to permit descent to 6000 feet QNH in VMC or by the approved NDB procedure in IMC provided that:

1. Cloud base to be 7000 feet or better.
2. Visibility reported to be 20 kms or better.
3. ASR is available and used to monitor flight below flight level 160.
4. No snow showers in the area.

Flight in the McMurdo area below flight level 160 will be restricted to an arc corresponding to a bearing of 120° Grid through 360° G to 270G from the NDB within 20 nm in order to keep well clear of the Mr Erebus region.

b. Two captains and a co-pilot will be crewed on each flight, they will receive a comprehensive briefing and complete a simulator detail involving a letdown and climb-out procedure, particular emphasis being placed on the use of grid navigation procedures."

1.17.29 Air New Zealand's letter of 10 August 1977 was acknowledged by CAD granting formal approval for the flights requested and further flights of a similar nature should they be required. They also approved the proposed descent to 6000 feet QNH in VMC or by the approved NDB procedure.

1.17.30 Air New Zealand Limited made a further application on 19 September 1978 for 4 flights in November 1978 with the statement "We propose to operate over the same routes as the previous charters, utilising the same crew training and operational procedures". DCA approved this request specifically noting that as for the previous year a descent to 6000 feet was approved under the same conditions.

1.17.31 In early 1979 some concern was felt within CAD regarding the need to carry survival equipment appropriate to the Antarctic area to honour the undertaking to observe all the standards in Annex 6 to the International Civil Aviation Organisation's Convention. The standard in this case being specified in Annex 6 paragraph 6.6 which reads as follows:

"Aeroplanes when operated across land areas which have been designated by the State concerned as areas in which search and rescue would be especially difficult, shall be equipped with at least one survival radio equipment, stowed so as to facilitate its ready use in an emergency, which operates on VHF and in accordance with the relevant provisions of Annex 10. The equipment shall be portable, not dependent for operation upon the aeroplane power supply, and capable of being operated away from the aeroplane by unskilled persons. Aeroplanes shall also be equipped with such signalling devices and life-saving equipment (including means of sustaining life), as may be appropriate to the area being overflown".

1.17.32 Investigations were being undertaken to establish the practice of other airlines flying over Arctic and Antarctic areas and as a result Air New Zealand Limited was written to on the subject in a letter from CAD on 9 August 1979 asking that the Company examine the equipment carried by Qantas and the protection made available together with the advantages and disadvantages which would be associated with a requirement for Air New Zealand Limited to carry similar equipment on all Antarctic flights.

1.17.33 On 27 September 1979 Air New Zealand Limited wrote to the Director of Civil Aviation advising him they were planning a further series of "charters" overflying Antarctica on November 7, 14, 21 and 28 and proposed to operate over the same routes as the previous year utilising the same crew briefing, training and en-route procedures.

1.17.34 On 3 October 1979 CAD granted approval for the proposed flights in 1979 and in a supplementary paragraph reminded Air New Zealand Limited that no reply had been received regarding their letter on the carriage of Antarctic survival equipment in the DC 10 aircraft for these operations.

1.17.35 On 10 October 1979 Air New Zealand Limited advised CAD that:

"It is our opinion that the carriage of survival suits is unwarranted as it would only be used in the event of a landing at McMurdo Airfield. This would only be as a result of a double engine failure or unfightable fire as other contingencies are covered, allowing for a return to Christchurch. These risks are also taken on all long haul operations over Arctic areas and although some operators do carry such gear, . . ., others do not. On the basis of infrequent exposure to an extremely unlikely emergency situation, Air New Zealand does not propose to carry survival equipment on the four scenic flights scheduled in November of this year."

1.17.36 The matter was under discussion informally between various officers of Air New Zealand Limited and the CAD Airline Inspectors as recently as 27 November 1979.

1.17.37 Civil Aviation Regulation 108 (2) states:

The Director may require the following equipment to be installed in any or all aircraft engaged in operations over areas in which search and rescue would be especially difficult.

(a) At least one approved emergency locator transmitter (ELT) stowed so as to facilitate its ready use in an emergency. The equipment shall be portable, have its own independent power supply and be capable of heing operated away from the aircraft hy unskilled persons.

(b) Such signalling devices and life-saving equipment (including means of sustaining life) as the Director considers appropriate to the area being flown over.

1.17.38 On 13 October 1977 the Commander of the USN Support Force in Antarctica advised in a message (No. 3100) to CAD Christchurch:

"UNLCAS // NO 3100 //
SUPPORT OF NON-SCAR ANTARCTICA FLIGHTS
A. YOU 130335Z PASEP
1. IRT REF A, AIR TRAFFIC CONTROL/FLGIHT FOLLOWING AND WEATHER FORECASTING SUPPORT FROM MCMURDO STATION WILL BE AVAILABLE ON A LIMITED BASIS AND FOR ADVISORY INFORMATION ONLY.
2. CURRENT REGULATIONS DO NOT PROVIDE FOR USN WEATHER FORECASTING ACCESSIBILITY TO COMMERCIAL CARRIERS. ADDITIONALLY, THE LIMITED ASSETS AT MCMURDO AND THE LACK OF REPORTING STATIONS FURTHER RESTRICT THE RELIABILITY OF REPORTED WEATEHR. THEREFORE, ANY ACTION TAKEN IN RESPONSE TO MCMURDO WEATHER REPORT MUST BE THE RESPONSIBILITY OF THE PILOT IN COMMAND.
PAGE 2 RBYWQH6497 UNCLAS
3. AIR TRAFFIC CONTROL/FLIGHT FOLLOWING SHALL TAKE THE FORM OF LOCATION ADVISORY OF DEEP FREEZE AIRCRAFT AND POSITION REPORT RELAY ONLY.
4. LIMITED SAR CAPABILITY EXISTS OVER LAND. VERY LITTLE OVER WATER.
5. REQUEST YOU ADVISE ALL PARTICIPANTS EXCEPT PAN AM WHICH HAS PREVISOULY BEEN DONE BY SEPCOR."

1.17.39 On 6 November 1979 a file note records that Air New Zealand Limited telephoned a CAD Airline Inspector and advised that as the McMurdo NDB had been withdrawn Air New Zealand DC 10s would descend below their safety height (in the McMurdo area) of 16000 ft only in VMC conditions, with no snow showers and with at least 20 km visibility. No descents would he made below 6000 feet. This information was reflected in an amendment DAA:14/13/28 of 8 November 1979, issued for the crew briefing sheets for flight TE 901 which stated:

McMurdo NDB not available
Delete all reference in briefing dated 23/10/79.
Note that the only letdown procedure available is **VMC** below FL160 to 6000' as follows:

1. Vis 20 km plus.
2. No snow shower in area.
3. Avoid MT EREBUS area by operating in an arc from 120° Grid through 360G to 270G from McMurdo Field, within 20 nm of TACAN CH29.
4. Descent to be co-ordinated with local radar control as they may have other traffic in the area."

A copy of this amendment was recovered from the cockpit wreckage.

1.17.40 On 22 November 1979 CAD advised Air New Zealand Limited that reports had been received from US Authorities in Antarctica that civil aircraft had been observed at lower than normal altitudes over some glaciers and at 1000 above ground level.

1.17.41 Security. The passengers for flight TE 901 were each subjected to the normal airport security check as for an international flight. No freight was carried and only the overnight baggage of passengers deplaning at Christchurch was carried in the cargo hold.

1.17.42 Radio propagation conditions. The magnetometer and ionosonde records made at Scott Base over the period 1200 (Z) 27 November to 1200 (Z) 28 November 1979 showed:

a. The 3-hourly index of magnetic disturbance (k-index) did not exceed a value of 3 (on a scale of 0-10) over the period.
b. The ionograms taken at 15 minute intervals showed no unusual ionisation changes over the period.

The Scott Base Senior Technical Officer of the Antarctic Division of the Department of Scientific and Industrial Research (DSIR) therefore concluded that there was no significant magnetic disturbance or evidence that radio propagation conditions would have been in any way abnormal for the period under consideration.

1.17.43 The Superintendent of the Antarctic Division of the DSIR studied all of the processed film that was recovered from that exposed by passengers on the flight and was able to determine and demonstrate that the aircraft had followed a track over Northern Victoria Land consistent with that intended on the aircraft's flight plan and had approached Ross Island on track. Before crossing the coast of Ross Island east of Beaufort Island however, the aircraft had obviously completed some descending turns. The photographs studied indicated that in many cases the last or second to last photographs were taken when the aircraft was in a position about 6 miles east of Beaufort Island, while the aircraft was heading in a southerly direction. In a number of other cases the last photographs (some taken only seconds before the collision) show the eastern shoreline of Cape Bird and the north eastern and north western coastline of Lewis Bay and a cloud layer with a base of some 2000 feet, above an unbroken snow covered slope.

1.17.44 The aircraft flew for some time within sight of Beaufort Island, which was clearly visible. The sun was shining on the north eastern slopes of Mt Bird with rock outcrops and the ice cliff face around this section of Lewis Bay clearly visible.

1.17.45 From the photographs the Superintendent deduced the following information on the weather. Over Northern Victoria Land the weather was clear with an almost complete absence of cloud at any altitude. The aircraft flew over continuous cloud layers from about Franklin Island to just north of Beaufort Island where the aircraft was able to descend through an obvious break in the cloud cover. Several photographs show a clearly defined cloud base beyond and above the Lewis Bay coastline of something less than 2000 feet.

1.17.46 Whiteout phenomenon. The following detailed information (paragraphs 1.17.46-1.17.58) was included in authenticated information supplied to the investigating team by the USN Antarctic Support force. Whiteout is an atmospheric effect which results in loss of depth perception and is especially common in Polar regions when there is snow cover. Only two conditions are necessary to produce a whiteout, a diffuse shadowless illumination and a mono-coloured white surface. Whiteout, it must be emphasised, is not necessarily associated with precipitation or fog or haze. The condition may occur in a crystal clear atmosphere or under a cloud ceiling with ample comfortable light and in a visual field filled with trees, huts, oil drums and other small objects.

1.17.47 In Polar regions these conditions occur frequently. Large unbroken expanses of snow are illuminated by a sky overcast with dense, low stratus clouds that blot out all trace of surface texture or shadow and merge hollows and snow covered objects into a flattened white background. In addition, cloud and sky may have the same apparent colour, so horizon discrimination is lost and the ground plane disappears. Whiteouts also occur in water or ice fog, blowing snow or precipitation conditions.

1.17.48 Those who have not been exposed to whiteout are often sceptical about the inability of those who have experienced it, to estimate distance under these conditions, (and to be aware of terrain changes and the separation of sky and earth).

1.17.49 The probable reason for the diffuse lighting which is responsible for a whiteout is a complex process where a large percentage of the light which penetrates the cloud cover is reflected back by the snow, and similarly is reflected by the white cloud undersurface, and so on. The transmission and reflection paths which this system develops are most complex as they pass from one water droplet or ice crystal to another through the cloud and are then reflected by the myriads of ice mirrors tilted in all directions on the snow surface. The consequence is that the light is diffused and results in a white shadowless lighting effect.

1.17.50 For the person operating on the ground, whiteout may only be a nuisance in that he may stumble and fall on terrain which appears to be flat but which actually has undulations. In crossing ice, crevasses may be missed.

1.17.51 For the pilot of the fixed wing aircraft there are several hazardous losses of perception. First there is the effect of loss of horizon, where it becomes impossible or very difficult to separate sky from earth since both are the same colour and to establish a ground plane. The result on an attempted landing may be misjudgement of the approach or a stall well above the surface, or else the pilot may fly the aircraft "into the ground".

1.17.52 A second major problem for pilots who must operate in winter with snow or ice landings where to strip exists is that they will have considerable difficulty assessing the condition of the terrain and determining whether it is flat or hummocky. They may, in landing encounter hummocks which cannot be avoided since they are literally not visible, and damage the aircraft and/or suffer injuries.

1.17.53 A third hazard reported by many pilots is disorientation, especially occurring on take off, where features such as trees which are providing a ground plane referenced are lost as the aircraft turns away from them and the pilot suddenly encounters a complete loss of references and height and altitude perception leading to disorientation.

1.17.54 Some flyers have also reported a phenomenon known as the "floating air strip", where a dark or black runway appears to be floating well above the apparent ground level once again resulting in disorientation.

1.17.55 One other hazard is the effect caused by dark coloured rocks or ridges visible above the snow, which may give the impression that good contrast conditions exist, resulting in a landing attempt on terrain which is not suitable for the purpose, but which due to the whiteout effect appears to be safe since the pilot has not realised that the dark colour of the rocks is giving the illusion of contrast.

1.17.56 The helicopter pilot is faced often with difficulty in estimating his distance above ground and establishing his attitude. A combination of loose snow with the characteristic snow cloud plus whiteout can make helicopter operations difficult.

1.17.57 In addition, a commonly reported problem is a loss of distance judgement or perception and it becomes difficult to estimate whether a perceived hill or hummock is a distant hill or a small protrusion a few feet away.

1.17.58 One of the most critical effects of a whiteout is a loss of height perception and this appears to be a problem for pilots during aircraft turns especially if there are marginally visible references.

1.18 New Investigation techniques

1.18.1 Three of the aircraft's navigation computers' memory modules were recovered from the accident site and returned to the manufacturer in an attempt to retrieve the flight plan waypoints that had been entered for flight TE 901 from Cape Hallett onwards. The manufacturer was able to retrieve all the information from one navigation computer unit (NCU) for the latter and remaining section of the flight which would normally be available in an undamaged installation. This included data not normally displayed or accessible to the pilots which the units provide for the calculation of the items displayed.

1.18.2 The detail of the flight plan recovered determined that the flight plan had been entered as specified on the computer printout for the route from Cape Hallett onwards, that no additional waypoints had been inserted in the vicinity of McMurdo and no offset from the flight plan track had been flown. It was also established that all three ISUs were indicating positions within the allowable accuracy limits for the time they had been operating.

1.18.3 It is important that, in such cases, no attempt is made to gain access to this equipment by installing the memory modules in an aircraft NCU. The recovery is a delicate task requiring special techniques. The modules should be carefully packaged and returned to the manufacturer for investigation and no attempt made to apply any current to the modules prior to the manufacturer's investigation.

2. ANALYSIS

2.1 The initiating factor in this accident was the captain's decision to make a VMC descent below the specified minimum safety height while north of McMurdo.

2.2 Although observing the Civil Aviation Regulations requiring the operator to brief the pilot in command for the particular route, Air New Zealand Limited as the operator, had not ensured that all significant information was included in the route qualification briefing and presented in an unambiguous manner or required the pilot in command to "demonstrate an adequate knowledge" of the subjects listed in Civil Aviation Regulation 77 paragraph 1(a).

2.3 The pilot in command had demonstrated to the operator in a flight simulator exercise, that he understood the salient points of the briefing relating to grid navigation. The flight simulator exercise also included a rehearsal of the arrival over Williams Field and a night VMC letdown procedure to 6000 feet AMSL following a simulated positioning by GCA north of Mt Erebus.

2.4 Although 2 of the pilots were shown a printout of the erroneous computer flight plan in advance of the actual flight they were not shown on a topographical map that the intended tack passed almost directly over the highest point in the area, Mt Erebus (12450 feet). Charts were carried in the aircraft on the day of the flight but these were very small scale (the largest scale was 1:3,000,000 with 1:1,000,000 insert of Ross Island) and not available to the crew until the final pre-flight dispatch planning on the morning of the departure. The 3 "maps" of the area between Cape Hallett and McMurdo which were used in the route qualification briefing all showed a track located clear of high ground and passing to the true west of the mountains as did one of he maps issued on the day of the flight. In fact the flight planned route passed to the east over very high ground instead of over the sea level ice shelf as portrayed on the briefing "maps". One track and distance diagram issued at the route qualification briefing showed that the track from Cape Hallett was direct to the McMurdo TACAN but this did not show the location of any topographical feature.

2.5 The flight plan was printed for each flight from a computer stored record which, until the night before the flight, had the longitude for the McMurdo destination point incorrectly entered as 164°48'E. The error in longitude had persisted for 14 months and was not corrected on the sample flight plan shown to this crew at their preliminary briefing. The error had been discovered 2 flights earlier but neither the crew of the previous flight nor that of the accident flight were advised of the error by the flight dispatcher prior to their departure. The error had placed the destination close to the longitude of the Byrd Reporting Point (165°E) and this aligned the track close to that displayed on the RNC chart and to that used by military aircraft. The fact that the computer error of over 2° of longitude to the west could exist for 14 months indicates there was no regular valid comparison between the topography and the geographical co-ordinates by briefing officers or flight deck crews. As all previous flights to McMurdo had approached the area in VMC earlier crews had not adhered to the flight plan track and hence had not detected the error. In the case of this crew no evidence was found to suggest that they had been mislead by this error in the flight plan shown to them at the briefmg.

2.6 Although the CAD Airline Inspectors involved had not witnessed a complete flight crew briefing for Antarctica one had witnessed the audio visual route qualification briefing twice and had approved it, on behalf of the DCA for familiarisation purposes, without requiring it to be amended in any way.

2.7 As a result of questions put to some of the pilots of earlier Antarctic flights and from the comments on the CVR record recovered from this flight, it was obvious that misconceptions were held about the flight level which was to be used for the resetting of the aircraft's altimeters to the local atmospheric pressure (QNH), the minimum altitude to which the aircraft was permitted to descend in VMC and the actual topography below the flight planned track from Cape Hallett to McMurdo.

2.8 Flight TE 901 progressed normally from Auckland to Antarctica and the weather was clear over Northern Victoria Land affording the passengers an excellent view of this scenic area. The passengers' photographs confirm the aircraft was on its planned track and turned over the appropriate point at Cape Hallett to proceed direct towards the next planned waypoint (the TACAN at Williams Field) near McMurdo.

2.9 During the leg of the flight from Cape Hallett to Williams Field the weather conditions over McMurdo and Ross Island generally were confirmed as overcast with a ragged cloud base of 3000 feet and the actual conditions at the Ice Runway 3 miles west of the TACAN were a cloud base of 2000 feet with 40 miles visibility below it but the surface and horizon definition were poor and snow showers had been reported. Messages from New Zealand bases in the area, to the aircraft indicated that the weather was clear over the Wright and Taylor Valleys and there were breaks in the cloud 75 to 100 miles north of McMurdo.

2.10 There was no explanation of the horizon and surface definition terms in the operators' route qualification briefing or pre-flight dispatch planning, and only a passing reference to whiteout conditions.

2.11 The direct flight from Cape Hallett to Williams Field was interrupted some 40 miles true north of McMurdo to take advantage of a hole, in the cloud cover, which extended vertically to sea level and to descend the aircraft in this gap prior to its planned arrival at McMurdo. The captain bad been advised that the visibility below the cloud which was over Ross Island, was 40 miles. This descent was made despite the safety requirements to maintain a minimum sector altitude of 16000 feet until overhead McMurdo TACAN and to descend below that height only in a specified sector and in weather conditions of 20 km visibility and no snow showers, and after contacting the radar controller.

2.12 Despite the Company's previous requirement for radar monitoring of the descent, the air traffic control centre staff at McMurdo had not been given an opportunity to study the altitude and area limitations imposed by Air New Zealand Limited for any of their aircrafts' descents in the area. The McMurdo Air Traffic Control officers were however, in possession of a chart which depicted the safe altitudes at various ranges and bearings from their radar installation for descents in the area.

2.13 When flight TE 901 requested a clearance for a descent from 10000 to 2000 feet on a heading of 180° Grid (i.e. towards the north) and to proceed to McMurdo VMC there was no reason for the Air Traffic Centre staff to question this as it was from a reported position to the true north of Ross Island and therefore the descent would take the aircraft back out over the sea level ice and the flight had confirmed it would maintain VMC inbound to McMurdo.

2.14 Had the crew followed their stated intention to descend on a heading of 180° grid they would have increased their safety margin from the high ground, but without further advice to "McMurdo Centre" the pilot in command reversed the aircraft's descent track and from 5800 feet the descent to 2000 feet was completed on a heading of 357° grid back toward the cloud covered high ground. This inbound track had a minimum safe altitude of 16000 feet. After reaching 2000 feet the aircraft captain announced he would descend a further 500 feet to obtain a better view below the continuous cloud layer and the first officer supported this by say "Yeah O.K. – probably see further in anyway".

2.15 The main altimeters were not reset from the standard setting until the aircraft was about 3500 feet on this inbound track for the last time although the flight level for this adjustment was 180. The substantial change in pressure (0.62 inches of mercury), meant the aircraft was actually 570 feet lower than indicated prior to the altimeters being reset. (The crew referred to altitudes of 13000 ft and above as flight levels). There was no evidence to suggest that the standby altimeter had not been set to the local QNH prior to descent as was the normal practice but neither could this be confirmed.

2.16 The captain had been qualified as a flight navigator and could be expected to keep a realistic mental plot of his position with regard to the juxtaposition of Mt Erebus, their next turning point, the inbound track and the distance to go. Although both he and the co-pilot would be more likely to be monitoring the area navigation computer display unit, the latitude and longitude indicators of the AINS were displaying the co-ordinates of an aircraft position slightly (3.1 nm) to the southwest of the actual position. This position although incorrect was within the accuracy limitations of the AINS and indicated that the aircraft was closer to Mt Erebus than was actually the case. The AINS would also indicate that the aircraft was on its flight planned track with the distance remaining equal to that which would place the aircraft close to the Lewis Bay coastline of Ross Island and heading towards Mt Erebus. Despite this and the aircraft's speed of 260 knots IAS (257 knots ground speed) the captain headed the aircraft toward the cloud covered island and no expression of doubt was made by the first officer. The captain descended the aircraft a further 500 feet from the original 2000 feet but at 1500 feet and at a distance to run of 26 miles he finally became concerned and stated "We're 26 miles north, we'll have to climb out of this".

2.17 The weather conditions as described had a high potential for a "whiteout" the phenomenon which is always likely when overcast conditions exist above a continuous snow covered slope (see 1.17.46 et seq). Various reports from aircraft which were flying in the area shortly afterwards indicated that the surface and horizon definition were poor. Whiteout conditions can exist within the normal VMC minima and even in the conditions defined by Air New Zealand as the minima for VMC descents to 6000 feet.

2.18 After the captain's decision to climb the aircraft out of the area he and the co-pilot were discussing the most suitable climbout path when the ground proximity warning system sounded instructing the crew to "Pull up". The crew responded to the alarm without undue hesitation, the flight engineer calling off the heights of 500 and 400 feet indicated on the radio altimeter and the captain calling for "Go-round power". The warning 6½ seconds before the impact was, however, too late for the crew's action to make any significant effect on the aircraft's level flight path. Their reaction time was established as very similar to or better than that of experienced crews placed in a similar situation in the training environment of the flight simulator. It is likely however that as a result of a whiteout the go-round attempt was procedural in response to the warning rather than a desperate attempt to avoid a readily apparent obstacle.

2.19 The ground proximity warning system's alarm was delayed because the terrain closure started from above a coastal cliff 300 feet high instead of a steadily increasing slope which would have triggered the warning approximately 3 seconds earlier. The system has an approximate 6 second delay after it first senses a dangerous closure rate with the terrain below the aircraft. This is to minimise spurious alerts triggered by short steep slopes below the aircraft during normal safe flight paths. Another factor was the aircraft's speed. The aircraft was closing with the slope at 257 knots. Although it could have been cruising at a lower speed with the flaps and slats, deployed, the extension of flats/slats in the Antarctic area was expressly prohibited by the operator owing to the difficulties which could occur in returning the considerable distance to the nearest landing point should a malfunction prevent retraction of the flats/slats. (260 knots was close to the minimum safe manoeuvring speed of 252 knots which was the $1.5V_s$ speed for the aircraft's all up weight in the clean configuration).

2.20 The pilot-in-command did not comply with the company's requirements to limit the descent to 16000 feet until overhead "McMurdo Field". He was not violating any local restriction by descending to 1500 feet in VMC or when he did not advise the ATCC when he altered his descent path from 180°G to 357°G. One explanation for his decision to continue on track toward McMurdo at this low altitude, was that it was the result of a misconception shared by himself, the first officer and the flight's official commentator that the approach path was over a sea level ice shelf to the west of Mt Erebus. There were discussions on the flight deck indicating that some of the speakers believed they were to the west of Mt Erebus but the 2 flight engineers on the flight deck had voiced frequent queries about the procedure and expressed their mounting alarm as the approach continued on at low level toward the area of low cloud. The pilots may also have believed that the would be able to see any obstruction within 40 miles as soon as they were below the 2000 foot cloud base but evidently this was not so. Observed conditions probably led to the particular snow slope and the cloud base appearing to the pilot as an area of limited visibility and this whiteout situation may well have been the deciding factor which made him announce his intention to climb out of the area.

2.21 The co-pilot advised the captain that there was no high ground to the right and the aircraft was clear to make a 180° turn whereas the terrain sloped up to 3500 feet to the right within 5 miles. Or within 2 miles of the position indicated by the AINS.

2.22 Once the aircraft was overdue the search and rescue operation was mounted with the appropriate dispatch but the weather prevented an immediate search of the terrain below the aircraft's track in the vicinity of the local high ground. After the wreckage was located further delays resulted due to adverse weather conditions despite determined efforts by helicopter crews to hover close to the ground adjacent to the site. An attempt was made to gain access to the site by surface travel but the high ice cliffs on the shore line and the numerous crevasses in the area made this impracticable.

2.23 There was no appropriate survival equipment on the aircraft and the weather conditions that prevailed after the accident coupled with the light summer clothing worn by almost all occupants would have minimised the chances of survival had any victim not been fatally injured by the impact even had they been able to make the optimum use of the undamaged items of the standard survival equipment fitted to the aircraft. The aircraft might well have touched down on the ice and remained sufficiently intact for some occupants to have survived had the angle of its flight path prior to the impact approached that of the ice slope more closely. In the event it was clear that no one survived the impact in this case.

2.24 A comprehensive study of the navigation equipment in conjunction with the crew's comments on the last 30 minutes of the flight as recorded by the CVR gave no indication that the area navigation system had displayed any erroneous information either by malfunctioning or incorrect input by the crew. (The actual error in the navigation presentation was 3.1 nm which was well within the allowable tolerance of 1.99 miles per hour since the last position update).

2.25 The CVR record revealed that the pilots' demeanour was composed and confident during the aircraft's approach to the accident area which was covered by a low overcast. The apprehension expressed by the flight engineers indicated that these members of the crew were endeavouring to monitor the flight responsibly but their suggestions of caution as with the captain's decision to climb out of the area were overtaken by the speed of the sequence of events. When the captain descended the aircraft outside of the approved area and below the minimum safe altitude the first officer did not criticise this decision. Although he was diverted to some extent in his endeavours to establish VHF communications as instructed by "Mac Centre" and endorsed by the captain, these VHF transmissions should not have overcome his natural caution in relation to cloud covered high ground. Had he been clearly aware that a 12450 foot mountain peak existed just 20 miles from destination on the planned track the simple selecting and monitoring of the AINS presentation showing distance to run and any divergence from the planned track could have overridden any preoccupation with operating the VHF radio.

3. CONCLUSIONS

3.1 The crew members were certificated and qualified for the flight.

3.2 The aircraft was certificated, equipped and maintained in accordance with CAD requirements.

3.3 The aircraft was airworthy and operating normally up to the time of the accident.

3.4 The aircraft's all up weight and C of G were within limits.

3.5 The flight planned route entered in the company's base computer was varied after the crew's briefing in that the position for McMurdo on the computer printout used at the briefing was incorrect by over 2 degrees of longitude and was subsequently corrected prior to this flight.

3.6 The system of checking the detailed flight plan entries into the base computer was inadequate in that an error of 2° of longitude persisted in a flight plan for some 14 months.

3.7 Some diagrams and maps issued at the route qualification briefing could have been misleading in that they depicted a track which passed to the true west of Ross Island over a sea level ice shelf, whereas the flight planned track passed to the east over high ground reaching to 12450 feet AMSL.

3.8 The briefing conducted by Air New Zealand Limited contained omissions and inaccuracies which had not been detected by either earlier participating aircrews or the supervising Airline Inspectors.

3.9 The crew were not aware of the VHF R/T callsigns in use in the area and these are not published in the briefing notes, the NZAIP, or the US Department of Defence documents which were available to the crew. They were however specified in US Navy instruction CNSFA INST 3722.1, a copy of which was held by Operation Deep Freeze Headquarters.

3.10 The question of making a landing near McMurdo on either the ice runway or the skiways at Williams Field and the type of emergencies which might require such a diversion was not discussed at the company's briefing.

3.11 The Civil Aviation Division Airline Inspectors had formally approved the audio visual stage of the route qualification briefing for the flight and one had witnessed a typical audio visual segment of the briefing for an Antarctic flight, twice, without requiring any amendments or detecting the errors contained in the briefing. They had also confirmed that it was no longer necessary for captains to carry out a supervised flight as required in the Operations Specifications in view of these briefings and the flight simulator detail.

3.12 Civil Aviation Regulation 77 1(a) bad not been complied with.

3.13 The operator departed from the stated undertaking to carry two captains on each flight and substituted an additional first officer in lieu of the second captain.

3.14 Of the flight deck crew only one engineer had flown to the Antarctic previously.

3.15 The crew were not monitoring their actual position in relation to the topography adequately even though a continuous readout of the aircraft's latitude and longitude and distance to run to the next waypoint was continuously available to them from the AINS.

3.16 The crew did not observe the transition level in use in the McMurdo air traffic control area for resetting this aircraft's altimeters and this procedure was not published in either the briefing notes or the US Department of Defence documents which were made available to the crew. The procedure used was that prescribed in US Federal Aviation Regulation 91.81 which required the QNH to be set basically at FL 180 during descent but this was modified in low pressure areas. (See Annex L).

3.17 The captain's altimeter was not set to the correct QNH until the aircraft reached 3500 feet.

3.18 The captain initiated a descent to an altitude below both the IMC (16000 feet) and VMC (6000 feet) minima for the area in a cloud free area but in contravention of the operator's briefing and outside the sector approved for the descent to 6000 feet by the DCA and the Company.

3.19 The co-pilot was devoting a significant proportion of his time in an endeavour to establish VHF contact with the McMurdo ground stations and did not monitor the decisions of the pilot in command adequately in that he did not offer any criticism of the intention to descend below MSA in contravention of company restrictions and basic good airmanship.

3.20 The descent was intentionally continued below the VMC limit specified by CAD and Air New Zealand Limited, of 6000 feet to an indicated 1500 feet.

3.21 The crew were distracted but not preoccupied by their failure to raise the Ice Tower or any local ground station on VHF, the failure of the DME to lock on to the TACAN and the lack of any identification of the aircraft on radar.

3.22 The company deleted an earlier requirement for VMC descents to be monitored by radar and substituted the alternative procedure of contacting the radar controller for co-ordination of the descent.

3.23 The failure of the aircraft's systems to establish satisfactory VHF contactor to "lock on" to the McMurdo TACAN was probably due to the aircraft's low altitude in conjunction with significant high ground between the aircraft and the ground equipment.

3.24 The flight engineers endeavoured to monitor the progress of the flight and expressed their dissatisfaction with the descent toward a cloud covered area.

3.25 Although the route selected by Air New Zealand for the approach to McMurdo crossed almost directly over a 12450 ft active volcano just 20 miles from destination in preference to the normal approach path of military aircraft which was across the sea level ice shelf the Air New Zealand route was safe provided the crew observed the minimum altitudes stipulated for the flight and no extraordinary activity occurred in the volcano.

3.26 Despite the shortcomings of some aspects of the route qualification briefing, this flight and Antarctic flights in general were not unacceptably hazardous, if they had been conducted strictly in accordance with the route qualification briefing as presented.

3.27 The CAD procedure of reapproving Antarctic flights each season on the condition that they complied with the constraints of the previous season's flights led to some items being discontinued without formal notification or agreement, e.g. the carriage of 2 captains on each flight, and the requirement for a briefing by ODF Headquarters.

3.28 The on board navigation and flight guidance system operated normally during the latter stages of the flight.

3.29 The aircraft's GPWS operated in accordance with its design specifications.

3.30 CAD had not implemented effectively the section of the ICAO standard detailed in Annex 6 of the convention which requires appropriate life-sustaining equipment to be carried on flights across land areas which have been designated by the State concerned as areas in which search and rescue would be especially difficult. Although the Commander of the USN Antarctic Support Force stated that "limited SAR capability existed over land and very little over water", this may not constitute "designation of the area" as being especially difficult for search and rescue activities by the State concerned.

3.31 Although some notes on Antarctic survival were given to the Chief Purser immediately before this flight no additional life-sustaining equipment was carried or training given to the crew members to facilitate survival following an emergency landing on the ice or in the polar waters of Antarctica.

3.32 Neither the passengers nor the crew were expecting the collision and all received fatal injuries on impact with the ice.

3.33 The search and rescue organisation was mobilised and co-ordinated in a competent manner despite the difficult environment and the aircraft was located as soon as practicable, (11 hours) after the collision occurred.

3.34 The aircraft was not fitted with a self activated ELT but such equipment is not at present required.

3.35 The aircraft's CVR and DFDR operated as intended and provided an excellent record for the investigators of this accident. The CVR system however could be significantly improved as discussed in recommendation 8.

3.36 The aircraft's radar would have depicted the mountainous terrain ahead.

3.37 Probable cause: The probable cause of this accident was the decision of the captain to continue the flight at low level toward an area of poor surface and horizon definition when the crew was not certain of their position and the subsequent inability to detect the rising terrain which intercepted the aircraft's flight path.

4. OBSERVATIONS

4.1 Although the accident would have been avoided if the aircraft had not descended below safety height it was not inevitable until the aircraft reaehed 1500 feet AMSL on track to McMurdo and maintained a heading toward GRID north. Had the aircraft been turned toward the true north even at that late state and either climbed to safety altitude or the crew pinpointed their position and headed towards lower terrain the accident could still have been averted. This is not to say that such a manoeuvre is in any way condoned. The pilot probably assumed that he would be able to see any and all obstructions clearly with a 2000 foot cloud base and 40 miles visibility below that cloud. It is not likely that the potential whiteout hazard indicated by the reports of horizon and surface definition was appreciated by the crew.

4.2 The operator claimed that "The whole philosophy behind the Air New Zealand Antarctic flights was for crews to avoid a whiteout situation (which has particular significance in a landing context not contemplated as part of the Air New Zealand operation) by remaining strictly VMC throughout the sightseeing part of the flight". It is emphasised that the absence of snow showers and visibility in excess of 20 km would not preclude the possibility of whiteout conditions occurring and affecting the crew's judgement of terrain clearance at any altitude.

5. RECOMMENDATIONS

5.1 The question of the necessity for the carriage of polar survival equipment be resolved before any further Antarctic flights are authorised.

5.2 The route qualification briefing for Antarctic flights be reviewed to ensure it is comprehensive and current.

5.3 No further flight to the Antarctic be approved by CAD until the operator's route qualification briefing has been reviewed

5.4 The co-pilots, flight engineers and the official commentators attend the route qualification briefings in addition to the pilot-in-command.

5.5 Briefing officers be familiar with the details of all routes for which they have the responsibility of providing operational briefing for flight crews and dispatch officers attend the initial briefing for each season's flights.

5.6 All entries into any operator's computer which stores flight plan information be independently checked immediately after they have been entered into the computer.

5.7 The operator discuss what emergency situations could involve an attempt to land at McMurdo's Williams Field and how the approach for such a landing should be made together with a full and up to date brief on the airfield locations, approach aids, Antarctic phenomena, and cabin crews' instructions to passengers.

5.8 Consideration be given to a requirement for all long range air transport aircraft flying over areas where search and rescue is unduly difficult be fitted with an inertia switch operated ELT fitted in the empennage.

5.9 Consideration be given to designing an inertia activated location transmitter or other indicator to be fitted in both the CVR and FDR units of all aircraft fitted with this equipment to assist in the prompt location and recovery of such recorders by the accident investigation team and thus enhance their contribution to the determination of the cause of the accident.

5.10 No descent below MSA be authorised in the Ross Island area unless the aircraft is under continuous radar surveillance.

5.11 For the purposes of flights to the Ross Dependency civilian operators accept the USN and FAA ATC procedures utilised by military aircraft as mandatory and approach McMurdo via the Byrd reporting point.

5.12 The Recommendation in Paragraph 6.3.3. of Part I of Annex 6 of the ICAO Convention on Civil Aviation "International Commercial Air Transport" be adopted by New Zealand as a standard practice. This Recommendation states "After 1 January 1975 all turbine engine aeroplanes of a maximum weight of over 5700 kg (12566 lb) up to and including 27000 kg (59525 lb) that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 should be equipped with a cockpit voice recorder the objective of which is the recording of the aural environment on the flight deck during flight time".

5.13 The CVR circuitry be rearranged to adopt the UK Civil Aviation Authority's "Hot Mike" system. This will enhance the value of the CVR without in any way altering present flight deck procedures and involves no significant expense.

5.14 The latest recommendation of the ICAO Accident Investigation Group to extend the length of the CVR tape to record more than the last 30 minutes of the CVR's operation be implemented as soon as practicable.

5.15 Strenuous efforts continue to ensure that each member of the flight crew is involved in all phases of a flight to utilise their full potential to contribute to the safe conduct of the flight particularly in actively endorsing or criticising the captain's management of the flight.

5.16 No commercial passenger carrying flight be planned to fly over or close to an active volcano.

5.17 Steps be taken to ensure that the number of persons on the flight deck does not exceed the number for which seats are available except in stable cruising flight conditions.

6. REGULATORY

6.1 Pursuant to Regulation 15(1) of the Civil Aviation (Accident Investigation) Regulations 1978, the legal representatives of the pilot-in-command, the co-pilot at the time of the accident, the operator and the Civil Aviation Division of the Ministry of Transport, were invited to avail themselves of the opportunities afforded them thereunder.

6.2 All parties presented written submissions and within the constraints of Regulation 15(3) these submissions were considered by the Chief Inspector of Air Accidents and the report was expanded and amended to incorporate relevant factual detail which was presented and to amplify areas which were considered ambiguous.

6.3 These submissions are not to be taken as an admission of liability of any kind on the part of the pilots, the operator or CAD and are without prejudice to their right to act as they think fit in any action or proceedings which may be based on the events to which the report refers. The provisions of Regulation 15(1) and 15(3) are accordingly deemed to have been fulfilled.

7. RECOGNITION

7.1 I wish to draw to the attention of all those who read this report that this investigation was only made practicable by the unselfish individual personal co-operation of all those members of the U.S. Navy, USAF, U.S. National Science Foundation, DSIR, RNZAF, N.Z. Police, the various Post Office staff, Department of Lands & Survey surveyors, N.Z. Meteorological Service meteorologists and all other N.Z. Government staff and private individuals at Scott Base, and the safety team of N.Z. mountaineers. Thanks are also due to those members of the investigating teams from the NTSB, FAA, McDonnell-Douglas Corporation, General Electric Co., U.K. Accidents Investigation Branch and Air New Zealand Limited who worked with no less effort or co-operation than the supporting personnel.

R. Chippindale
Chief Inspector Air Accidents

30 May 1980

Annex A
To Report 79-139

CABIN CREW CURRENCY
FLIGHT – PROCEDURES
TE 901 – 28 NOVEMBER 1979

		Last DC 10 Refresher Course	Last Avmed Refresher Course	Last Day of Flight	Flight Hours since 31 Oct 79
Chief Purser	McPherson, Roy William	9 May 79	21 Jun 79	23 Nov 79	47
Purser	Collins, Martin John	6 Jun 79	14 May 79	25 Nov 79	54
Purser	Scott, Russell Morrison	4 Jul 79	2 Aug 79	22 Nov 79	58
Assistant Purser	Bennett, David John	26 Jan 79	18 Jun 79	25 Nov 79	50
Assistant Purser	Findlay, Michael James	1 Jun 79	15 Feb 79	23 Nov 79	25
Senior Cabin Crew Member	Carter, Graham Ronald	2 May 79	8 Feb 79	16 Nov 79	41
Senior Cabin Crew Member	Marinovic, Suzanne Margaret	4 May 79	19 Apr 79	24 Nov 79	59
Senior Cabin Crew Member	Maxwell, Bruce Rhodes	8 Jun 79	18 Jun 79	22 Nov 79	61
Cabin Crew Member	Keenan, Dianne	20 Jun 79	5 Mar 79	26 Nov 79	18
Cabin Crew Member	Lewis, James Charles	7 Feb 79	30 Aug 79	26 Nov 79	37
Cabin Crew Member	Morrison, Katrina Mary June	23 Mar 79	25 Jun 79	23 Nov 79	45
Cabin Crew Member	Sicklemore, David Brian	17 Jan 79	9 Aug 79	16 Nov 79	34
Cabin Crew Member	Simmons, Stephen George	3 Aug 79	3 Sep 79	25 Nov 79	46
Cabin Crew Member	Wolfert, Marie-Therese	17 Jan 79	26 Mar 79	22 Nov 79	63
Cabin Crew Member	Carr-Smith, Elizabeth Mary	11 Jul 79	2 Apr 79	22 Nov 79	35

Annex B
To Report 79-139

EXPLANATION OF ANTARCTIC HORIZON AND SURFACE DEFINITIONS

GUIDE TO THE DEGREE OF SURFACE DEFINITION:

GOOD	SNOW SURFACE FEATURES SUCH SASTRUGI, DRIFTS, AND GULLIES ARE EASILY IDENTIFIED BY SHADOW. (THE SUN IS USUALLY UNOBSCURED).
FAIR	SNOW SURFACE FEATURES CAN BE IDENTIFIED BY CONTRAST. NO DEFINITE SHADOWS EXIST. (THE SUN IS USUALLY TOTALLY OBSCURED).
POOR	SNOW SURFACE FEATURES CANNOT BE READILY IDENTIFIED EXCEPT FROM CLOSE UP. (THE SUN IS USUALLY TOTALLY OBSCURED).
WHITEOUT	SNOW SURFACE FEATURES CANNOT BE IDENTIFIED. LOSS OF HORIZON, THE SNOW SURCACE MERGES WITH THE WHITENESS OF THE SKY. NO SHADOWS OR CONTRAST EXIST. DARK COLOURED OBJECTS APPEAR TO "FLOAT" IN THE AIR. (THE SUN IS TOTALLY OBSCURED ALTHOUGH THE OVERCAST MAY EXHIBIT CONSIDERABLE GLARE ..... THE GLARE APPEARS TO BE EQUALLY BRIGHT FROM SURFACE RELFECTION ..... AND FROM ALL DIRECTIONS).

GUIDE TO THE DEGREE OF HORIZON DEFINITION:

GOOD	THE HORIZON IS SHARPLY DEFINED BY SHADOW OR CONTRAST.
FAIR	THE HORIZON MAY BE IDENTIFIED ALTHOUGH THE CONTRAST BETWEEN SKY AND SNOW SURFACE IS NOT SHARPLY DEFINED.
POOR	THE HORIZON IS BARELY DISCERNIBLE.
WHITEOUT	TOTAL LOSS OF HORIZON, THE SNOW SURFACE MERGES WITH THE WHITENESS OF THE SKY.
NO HORIZON	TOTAL LOSS OF HORISON DUE TO CONDITIONS OTHER THAN WHITEOUT, E.G. BLOWING SNOW, FOG, ICE FOG.

NOTE: OCCASIONALLY A POOR OR NO HORIZON CONDITION WILL OCCUR IN ONE DIRECTION ONLY. REPORT THIS CONDITION: AS POOR HORIZON SOUTH THRU WEST, OR NO HORIZON EAST, FOR EXAMPLE.

Annex C
To Report 79-139

ABRIDGED TRANSCRIPT OF A SUNDSTRAND, MODEL B
COCKPIT VOICE RECORDER, SERIAL NO. 256
REMOVED FROM ZK-NZP
(FLIGHT TE 901) WHICH WAS INVOLVED
IN AN ACCIDENT AT ROSS ISLAND ON
28 NOVEMBER 1979
THE TIME IS GMT

Note: Air-Ground communications are co-ordinated with and supplemented by ground based recordings.

LEGEND

CAM	Cockpit area microphone voice or sound source
RDO	Radio transmission from:
-1	Voice identified as Captain
-2	Voice identified as Co-pilot
-3	Voice identified as Flight Engineer (Brooks)
-4	Voice identified as Flight Engineer (Malone)
-5	Voice identified as P. Mulgrew
-?	Unidentified voice
CTR	McMurdo Centre/Ice Tower
*	Unintelligible word
%	Background conversation not pertinent to the operation of the flight
( )	Questionable text
(( ))	Editorial insertion
- - -	Pause
@	Ground Proximity Warning System
(HF/VHF)	Type of Transmission

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
			*****
		0017:00 CAM-4	Do you want any landing data about here?
		CAM-1	No
		0017:05 CAM-4	You've just got your altimeters to set through transition
		0017:13 CAM-1	I think we'll start down a little early here
		CAM-2	OK, I'll see if I can get hold of them on VHF
0017:40 RDO-2 (VHF 2)	McMurdo New Zealand nine zero one		%
		0017:53 CAM-?	How far away were we (from McMurdo)
0017:55 CTR (HF)	New Zealand 901 this is the Mac Centre Forecaster Over		
		0017:56 CAM-?	About a hundred and forty miles
0017:59 RDO-2 (HF)	Roger Mac Centre New Zealand 901 go ahead		

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & souree**	**Content**
0018:05 CTR (HF)	Yes sir. If you have copied our latest weather we have a low overcast in the area (at) about 2000 feet and right now we're having some snow but our visibility is still about 40 miles and if you like I can give you an update on where the clear areas are around the local area		
		0018:11 CAM-1	Clouds come down a bit *** may not be able to ** McMurdo. Very hard to tell the difference between the cloud and the ice **
			%
		0018:27 CAM-1	** better conditions ** before
0018:29 RDO-2 (HF)	Yes 901 that would be handy we'd like to descend to flight level 160		
0018:41 CTR (HF)	Kiwi 901 Mac Centre descend and maintain flight level 180 over		
0018:47 RDO-2 (HF)	Roger 901 - - - flight level 180		
		0019:22 CAM-?	That'll be round Cape Bird wouldn't it?
		CAM-?	Right Right

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
0018:52 CTR (HF)	901 this is the forecaster again it looks like the clear areas around McMurdo are at approximately between 75 to 100 miles to the northwest of us (but) right over McMurdo we have a pretty extensive low overcast over		
0019:14 RDO-2 (HF)	Roger . . New Zealand 901 thanks	CAM-4	Got a low overcast over McMurdo
		0019:39 CAM-1	Doesn't look very promising does it?
		CAM-2	No
		CAM-4	No
0019:47 CTR (HF)	Kiwi 901 Mac Centre		
0019:49 RDO-2 (HF)	Centre New Zealand 901		
0019:56 CTR (HF)	Roger within a range of 40 miles of McMurdo we have a radar that will, if you desire, we can let you down to one thousand five hundred feet on radar vectors over		
0020:07 RDO-? (HF)	Roger New Zealand 901 that's acceptable		

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
0020:11 CTR (HF)	Roger		
		0020:17 CAM-1	* that's what we want ***
		CAM-?	** going down
		0020:20 CAM-2	** one hundred and fourteen miles **
0020:28 CTR (HF)	Kiwi 901 McMurdo Centre, estimate your DME from McMurdo – over ((not recorded on CVR tape due reversal))		%
		0020:30 PA-1	- Gents we're going initially to eighteen thousand and the cloud cover in the McMurdo area has increased although the visibility is forty kilometres so ground visibility is good and we - - - will be taking advantage of the radar facilities at McMurdo for letdown which should take us below the cloud and give us a view of the McMurdo area, that is always likely to change of course depending on any variations in the weather but we're hopeful we'll be able to give you a look at McMurdo today. Thank you.
0020:33 RDO-2 (HF)	Roger we're approximately one one four		

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
0020:40 CTR (HF)	Kiwi niner zero one confirm one hundred and ninety four one niner four		
0020:46 RDO-1 (HF)	Negative on one four one hundred and fourteen		
0020:58 CTR (HF)	Kiwi nine zero one attempt contact one two six decimal two	CAM-3	We're going below cloud, letting down below cloud ((comment to unknown person))
0021:05 RDO-2 (HF)	Roger niner zero one	CAM-2	Try another receiver
0021:14 RDO-2 (VHF 2)	Mac Centre New Zealand nine zero one on one two six two do you read		
0021:42 RDO-2 (VHF 1)	Mac Centre New Zealand nine zero one on one two six two do read?		% ((Rustling paper))
		0022:29 CAM-1	What's the weight here?
	((Calls to and from South Pole/Mac Centre))	CAM-3	A hundred and ninety-nine and a half %

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		0023:07 CAM-1	We'll have a minimum of two sixty ((knots))
		CAM-2	OK beauty
		0023:11 CAM-1	It's actually two fifty two for one point five
0023:30 CTR (HF)	Kiwi niner zero – correction New Zealand niner zero one – New Zealand – nine zero one Mac Centre how do you read?		
	((South Pole transmissions))		
		0023:36 CAM-?	We've got ninety miles to go but ah
		0023:48 CAM-3	Did he call nine zero one then or - - - ?
0023:50 RDO-2 (HF)	Mac Centre New Zealand nine zero one on ah eight nine nine seven - - no reply on one two six two		
0023:58 CTR (HF)	New Zealand nine zero one Roger, do you have a good lock on our Tacan channel twenty-two niner channel two niner over		%
0024:05 RDO-2 (HF)	Negative at this point. Confirm the frequency one zero niner point two		

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
0024:17 CTR (HF)	Roger our Tacan channel is two niner-two niner		
0024:24 RDO-2 (HF)	Roger New Zealand nine zero one standby	CAM-3	Have you got the radio information - - - right get yourself the Tacan frequency
0024:31 CTR (HF)	Kiwi nine zero one contact tower at one three four decimal one		
0024:38 RDO-2 (HF)	Understand one three four decimal four		%
0024:42 CTR (HF)	That's one three four decimal one		
		0024:44	((Sound of altitude alert))
0024:47 RDO-2 (HF)	Roger – one three four decimal one		
		0024:51 CAM-?	Nav track – Alt Cap
			%

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
			*
0025:14 RDO-2 (VHF 1)	Mac Tower this is New Zealand nine zero one on one three four decimal one do you read?		%
		CAM-3	** on the radio licence
			%
		CAM-1	Do you want to try the tower?
		CAM-2	That's what I've just tried
0025:42 RDO-2 (VHF 1)	Mac Tower New Zealand nine zero one on one three four one do you read?		
		0025:56 CAM-I	Try them again on one two six two
0026:00 RDO-2 (VHF 1)	Mac Centre this is New Zealand nine zero one on one two six do you read		%
		CAM-?	*****
0026:14 to 0026:35 CTR (VHF)	((Ice Tower called 901 twice – not recorded on CVR))		Well I had a yellow book on this
			%

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
0027:09 RDO-2 (VHF 1)	Mac Tower this is New Zealand nine zero one on one three four decimal one do you read		
0027:28 RDO-2 (HF)	Mac Centre this is New Zealand nine zero one on eight nine there's no reply on one three four one	CAM-1	Nothing at all
			%
0027:35 CTR (HF)	New Zealand niner zero one roger, Mac-Ice Tower is attempting contact on both one three four decimal one and one two six decimal two. Attempt contact when you're approximately 80 DME over.		
		0027:45 CAM-?	((Laughter))
			((Conversation relevant to change of visitors to flight deck))
0027:47 RDO-1 (VHF 1)	Ah McMurdo Tower New Zealand nine zero one on one three four decimal one do you read? ((Not recorded on ground tape))		%
		0028:47 CAM-2	You didn't get the Tower did you?
-?	(Mac Centre Mac 40643)		
0029:02	Air New Zealand niner zero one Mac Centre do you have		

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
CTR (HF)	uniform hotel foxtrot frequencies		
		CAM-1	No, negative, no we haven't got it
0029:11 RDO-2 (HF)	Negative New Zealand nine zero one		
0029:15 CTR (HF)	Roger – standby Ice Tower is trying to contact you on both one twenty six two and one three four point one		
0029:24 RDO-2 (HF)	Roger thanks		
0030:09 CTR (VHF)	Air New Zealand 901 McMurdo Tower ((Not recorded on CVR))		
		CAM-? 0029:38 CAM-1	If we go lower *** cabin depressurised I'll just give him a call on one two six two
0029:44 RDO-1 (VHF 2)	Ah McMurdo New Zealand nine zero one one two six two do you read? ((Not recorded on ground))		
0030:12 RDO-1 (VHF 2)	Ah McMurdo nine zero one on one two six do you read ((Not recorded on ground))		%

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		0030:30 CAM-1	Can you hear him there at all?
		CAM-2	No
		CAM-4	No
			%
0030:35 RDO (VHF 1)	Ah Mac New Zealand ah - - - nine zero one on one three four decimal one zero do you read ((Not recorded on ground))		
		0031:01 CAM-1	I'll have to do an orbit here I think
			%
		0031:08 CAM-1	Well actually it's it's clear out here if we get down - - - and
		CAM-?	It's not clear on the right hand side here
		CAM-2	No
		0031:20 CAM-1	If you can get HF contact tell him that we'd like a further descent – we have contact with the ground and we could if necessary descend doing an orbit
		0038:28 CAM-2	OK

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
0031:37 RDO-2 (HF)	Mac Centre New Zealand nine zero one		
			%
0031:41 CTR (HF)	New Zealand nine zero one Centre go ahead		
0031:44 RDO-2 (HF)	Roger New Zealand nine zero one still nothing on one two six two or one three four decimal one - - -		
0032:07	We'd like further descent or we could orbit in our present position which is approximately forty three miles north – descending VMC		
0032:08 CTR (HF)	Roger Kiwi New Zealand nine zero one, VMC descent is approved and keep Mac Centre advised of your altitude		
0032:10 RDO-2 (HF)	Roger New Zealand nine zero one we're vacating one eight zero we'll advise level		
		0032:22 CAM-1	I'll come round there and set that down (at) ten thousand
		CAM-2	OK
			%

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		0032:33 CAM-?	They give us ten thousand?
		CAM-?	No clearance
		CAM-2	Got to keep them advised
		CAM-3	No but see if we can descend VMC
		0032:45 CAM-1	I'll do an orbit here to get down I think - - - and keep them advised of our altitude
		033:01 -?	I see alt, heading select, vert speed
0033:17 CTR (VHF)	Air New Zealand 901 Mac Centre how do you hear? (Not recorded on CVR))		
		0033:21 CAM-3	We are descending below cloud now so better photographs soon
		CAM-?	Ah ah ((Japanese voice))
		CAM-1	Actually it's clear ahead there
		CAM-3	We're going down below cloud
		CAM-1	No I can't
		CAM-1	I'd better come round (here) (again)

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		CAM-4	Are we (continuing) to ten thousand at (this speed)
		CAM-3	McMurdo's here but we are going down and then we'll go to McMurdo once we get down below the cloud
0033:34 CTR (HF)	Kiwi 901 – Correction Air New Zealand 901. Recycle your transponder – squawk 0400 – ((Not recorded on CVR))		
		CAM-I	Three thirty five eight two yes well I won't be doing eight two
		CAM-4	Right
		CAM-1	Just one point five speed
		0033:51 CAM-4	That's if you want to go past six.
			%
		034:21 PA-1	Captain again ladies and gentlemen we're carrying out an orbit and circling our present position and will be descending to an altitude below cloud so that we can proceed to McMurdo Sound - - - thank you.
		-2	Damn – I had whole series of figures – visual figures holding TACAN during the descent.

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		-?	Excuse me, will it be difficult to get down and see Scott Base
		-?	They'll have no problem when we x x x x x.
		-?	Thanks
		0035:15 CAM-2	Transponder is now responding
		CAM-1	OK
		0035:20 CAM-4	Still no good on that frequency though?
		CAM-2	No
0035:27 RDO 2 (VHF 1)	Mac Tower this is New Zealand nine zero one on one three four decimal one do you read		
0035:33 CTR (VHF)	Air New Zealand nine zero one you're loud and clear		
0035:36 RDO 2 (VHF 1)	Roger nine zero one you are now loud and clear also we are presently descending through flight level one three zero VMC and the intention at the moment is to descend to one zero thousand		%
0035:52 CTR	Roger understand you will be descending to one zero thousand VMC and you are requesting a radar letdown		

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
(VHF)	through the cloud		
		0035:53	((Sound of altitude alert))
0036:00 RDO 2 (VHF 1)	That is affirmative nine zero one		%
0036:10 to 0038:29	((Ice Tower (VHF) made six calls to 901. These were not recorded on the CVR))	0036:18	((Sound of altitude alert))
		0036:20 CAM-1	Are we cleared below one one thousand
		CAM-2	No I told him we were going down to ten
		0036:25 CAM-1	Oh I see all right
			%
		0036:32 CAM-2	We've lost him again
		?	Yes
		0036:34 CAM-4	Ten thousand armed I see
0036:37 RDO 2	Ah New Zealand nine zero one do you read?		%

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
(VHF 1)			
	((Not recorded on ground tape))	0036:48	((Sound of altitude alert))
			%
		0037:06 CAM-1	Well no the cloud base is low and ah
		BREAK IN TAPE 1719 – 1723	
		0037:20 CAM-4	You're through ten thousand are you going to hold it here
		CAM-1	Yep
0037:27 RDO-2 (VHF 1)	Mac Tower New Zealand nine zero one we seem to have lost contact again were level at ten thousand feet in the ah VMC		
	((Not recorded on the ground tape))		
			%
		0037:45 CAM-2	I'll go back to HF Jim
		CAM-1	OK
		0037:54 CAM-1	Well we're having trouble with communications right now so if you'll just wait there and see what we come up with

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
			((Comment to person/s unknown))
			%
0038:07 RDO-2 (VHF 2)	Mac Tower New Zealand nine zero one how do you read now one three four one		
	((Not recorded on the ground))		
		0038:23 CAM-1	I've got to stay VMC here so I'll be doing another orbit
0038:29 RDO-2 (HF)	Mac Centre this is New Zealand nine zero one on eight nine		
CTR (HF)	901 loud and clear go ahead		
0038:38 RDO-2 (HF)	Roger nine zero one we briefly had contact on one three four one we've now lost contact we're maintaining ten thousand feet presently thirty four miles to the north of McMurdo		
0038:47 CTR (HF)	Niner zero one Roger your lost comms with the tower say again your altitude?		
			%

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & souree**	**Content**
0039:07 RDO-2 (HF)	Roger we're maintaining one zero thousand – ten thousand		
0039:16 CTR (HF)	OK Roger and keep trying the Tower one two six decimal two and one three four point one they heard you too sir		
0039:25 RDO-2 (HF)	Roger dee		
0039:32 RDO-2 (VHF 1)	Mac Tower New Zealand nine zero one on one two six two do you read? ((Not recorded on ground tape))		
0040:05 RDO-2 (VHF 2)	Mac Tower New Zealand nine zero one on one three four one do you read? ((Not recorded on ground tape))		
		0040:19 CAM-4	Try putting number two on that frequency
		0040:28 CAM-3	Lost contact when we got down a bit lower
0040:43 RDO-2 (VHF 2)	Mac Tower New Zealand niner zero one on one three four decimal one do you read?		

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
	((Not recorded on ground))		
		0040:56 CAM-1	Wonder if they can get us on one two one five then?
			(Ratchet sound)
			%
		0041:15 CAM-2	Right - - - shall I try it on one two one five?
0041:25 RDO-2 (VHF 1)	Ah McMurdo New Zealand nine zero one on one two one five do you read?		
	((Not recorded on ground))		
		0041:34 CAM-1	Well look go back to HF
		CAM-2	Yes
		0041:00 CAM-1	Tell him we can make a visual descent descending
	(Interjection)	0401:45 CAM-?	My God
		CAM-1	On a grid of one eight zero
		CAM-2	Yes

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		CAM-1	And make a visual approach to McMurdo
		CAM-2	OK
0041:55 RDO-2 (HF)	Ah Mac Centre New Zealand (901 on eight nine) ((Words in brackets interrupted by Voice recorder test signal))		
CTR (HF)	Zero one Mac Centre go ahead		
0042:01 RDO-2 (HF)	Roger nine zero one still negative contact on VHF we are VMC and we'd like to let down on a grid of one eight zero and proceed visually to McMurdo		
042:15 CTR (HF)	New Zealand niner zero one maintain VMC keep us advised of your altitude as you approach McMurdo over		
0042:24 RDO-2 (HF)	Ah Roger nine zero one we will maintain VMC		
		0042:27 CAM-1	Well we're just going VMC to McMurdo and then come back in
		0042:31 CAM-2	Turn two thousand on the *** (instruments)
0042:34 CTR (HF)	New Zealand niner zero one Mac Centre report ten DME from McMurdo		

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
0042:40 RDO-2 (HF)	Ah Roger nine zero one to report ten DME McMurdo		
		0042:46 CAM-2	Two thousand feet (yeah ((interjection))) is set-armed
		-?	OK
		CAM-1	Right. Are your headings OK
		CAM-?	IAS hold IAS hold
		0042:49 CAM-1	We're VMC around this way so I'm going to do another turn in
		0042:59 CAM-1	Sorry haven't got time to talk but
		CAM-5	Ah well you can't talk if you can't see anything
		0043:02 CAM-1	Both the VHF channels that they use here we're not picking them up at fifty miles
		0043:20 CAM-3	** Do you want to swap around while he's (commentating)?
			%
		-5	Nothing to commentate on as yet!

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		0043:27 CAM-5	There you go there's some land ahead
		-?	Yep
		-?	((Where's)) Mt Erebus
		-?	North of McMurdo
		0043:35 CAM-1	I'll arm the nav again
		CAM-2	OK
		0043:38 CAM-1	Alt Nav Cap IAS hold
		0043:50 CAM-2	I'll go back to one two six two eh Jim?
		CAM-1	OK
		%	
		0044:06 CAM-1	Keeps you busy on comm doesn't it?
		CAM-2	Well you know its ah a bit of a nuisance
		-?	Where are we?
CTR	Gentle 17 – Gentle 17 Mac Centre	-3	About up to here now?

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
	Mac Centre be advised – be advised a DC one zero VMC en route McMurdo from the North – Mac Centre out		((sound of rustling paper))
			%
0044:36 CTR (HF)	New Zealand niner zero one Mac Centre if possible give us a tops report on the cloud layers		
		0044:44 CAM-1	OK at fifty miles north it was ten thousand
		CAM-2	OK
0044:47 RDO-2 (HF)	Roger New Zealand nine zero one fifty miles north the base was one zero thousand ten thousand		
0044:57 CTR (HF)	Understand bases are at ten thousand?		
0045:00 RDO-2 (HF)	Affirmative we are now at six thousand descending to two thousand and we're VMC		
0045:08 CTR (HF)	Nine zero one Roger		
		0045:08	((ratcheting sound similar to heading knob reselection))

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		0045:18 CAM-3	Yes we'll be going down to five thousand feet and then to McMurdo – we going down to two
		CAM-?	Roger
		CAM-3	We're going down to two
		0045:26 CAM-1	We had a message from the Wright Valley and they are clear over there
		CAM-5	Oh good
		0045:31 CAM-1	So if you can get us over that way
		0045:33 CAM-5	No trouble
		CAM-1	Right
		0045:36 CAM-5	The Taylor or the Wright now or do yah?
			%
		-1	No I prefer here first!
			%
		0046:02 PA-5	One second – This is Peter Mulgrew speaking again folks I still can't see very much at the moment keep you informed soon as I see something that gives me a clue as

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
			to where we are
		-?	((interjection)) altimeters
		0046:14 CAM-1	Two nine three oh - - - right
		CAM-2	Yes
		0046:19 PA-5	We're going down in altitude now and it won't be long before we get quite a good (view)
		0046:21 CAM-2	A thousand to go
		CAM-1	OK
		0046:24 CAM-2	Alt, Nav Track, Vert Speed
		CAM-I	Speed
			(Rustling Paper)
		0046:28 CAM-2	Speed I see
			(Rustling Paper)
		0046:35	((sound of altitude alert))
		0046:39	Where's Erebus in relation to us at the moment

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		CAM-3	
		CAM-?	Left about (twenty)or (twenty) file miles
		0046:43 CAM-?	Left do you reckon
		CAM-?	Well I don't know - - - I think
		CAM-?	I've been looking for it
		-2	Yep Yep
		0046:46 CAM-?	I think it'll be erh
		0046:48 CAM-3	I'm just thinking of any high ground in the area that's all
		CAM-5	I think it'll be left yes
		CAM-4	Yes I reckon about here
		CAM-5	Yes - - - no no I don't really know
		0047:02 CAM-5	That's the edge
		0047:06 CAM-?	Down to two thousand feet

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & souree**	**Content**
		CAM-1	Yes
		CAM-2	Yes
		CAM-3	IAS hold
		0047:20 CAM-1	You've got speed set up there anyway haven't you
		0047:23 CAM-4	Alt Cap
		-2	Yes Alt Cap (nav) track
		0047:28 CAM-1	Speed, nav track, alt - - -
		-?	Altitude (acquired)
		-?	What's wrong
		-?	Make up your mind soon or - - -
			%
		0047:43 CAM-1	We might have to pop down to fifteen hundred here I think
		CAM-2	Yes OK
		0047:47 CAM-2	Probably see further in anyway
		0047:49	((sound of altitude alert))

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		CAM-2	It's not too bad
?	I'll call you – I'll call you back		
		0047:55 CAM-2	I see vert speed for fifteen hundred feet
		CAM-4	** it's not right
		-?	Bit thick here eh Bert?
		0047:59 CAM-4	Yeah my …… oath
		0048:05 CAM-4	You're really a long while on …… instruments this time are you
		(-5 ((0048:10 (CAM-3 ((CAM-5 ((CAM-4 ((? ((CAM-5 - 1	I reckon Bird's through here and Alt Cap Ross Island there Yes Alt Hold Erebus should be here Right
	((overlapping conversation))		

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & souree	**Content**	**Time & souree**	**Content**
		0048:12 CAM-2	(Terrain) fifteen hundred
		0048:20 -?	Capture
		0048:22 CAM-22	Alt hold
		0048:23 CAM-3	Hold on both, nav track
		0048:30 CAM-1	We didn't get that Tacan frequency did we?
		CAM-2	No
		0048:36 CAM-3	(Have) we got the latest AIRAD * on the aircraft?
		0048:38 -?	What's the frequency one oh nine two?
		0048:40 CAM-2	Well we think that's what it is but it's channel twenty nine
		0048:46 CAM-1	Actually those conditions don't look very good at all – do they?

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & souree**	**Content**
		CAM-5	No they don't
		0048:50 CAM-5	You're down at one one four now are you?
		0048:51 CAM-1	Fifteen hundred
		CAM-5	Yes
		0048:55 CAM-1	Have we got them on the tower?
		0048:59 CAM-2	No - - - I'll try again
		0049:00 CAM-4	(only got 'em on HF that's all)
		0049:04 CAM-1	Try them again
		CAM-2	OK
		0049:08 CAM-5	That looks like the edge of Ross Island there
0049:10 RDO-2 (VHF 2)	Mac Tower this is New Zealand nine zero one on one three four one do you read?		
		0049:24	I don't like this

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		CAM-3	
			%
		0049:25 CAM-1	Have you got anything from him?
		-?	No
		CAM-2	No
		0049:30 CAM-1	We're twenty six miles north we'll have to climb out of this
		CAM-?	OK
		0049:33 CAM-2	It's clear on the right and (well) ahead
		CAM-1	Is it?
		CAM-2	Yes
		0049:35 CAM-?	You can see (Ross Island) Right Fine!
		0049:38 CAM-2	Yes you're clear to turn right there's no high
		-?	Is it
		-5	Yes

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		CAM-1	No negative
		CAM-2	No high ground if you do a one eighty
		0049:44 @	Whoop Whoop
		@	Pull up
		@	Whoop Whoop
		0049:48 CAM-3	Five hundred feet
		@	Pull up
		CAM-3	Four hundred feet
		@	Whoop Whoop
		CAM-?	Pull up
		@	Pull up
		@	Whoop Whoop
			((Reduced volume))
		@	Pull up
		CAM-1	Go round power please

AIR-GROUND COMMUNICATIONS		INTRA-COCKPIT	
Time & source	**Content**	**Time & source**	**Content**
		@	Whoop Whoop
		@	Pull - -
		0049:50	((End of Recording))
From 0049:50 CTR (VHF)	Call six times on VHF and HF to which there was no reply. McMurdo Centre asked local aircraft to call 901 from which there was also no reply		

Annex D
To Report 79-139

ANALYSIS OF COCKPIT VOICE RECORDER ANDDIGITAL FLIGHT DATA RECORDER DATA EX AIR NEW ZEALAND DC 10 ZK NZP

Introductory Notes:

1. All times quoted in this report are in GMT, as this was considered the most accurate time base. This is the time used in the accident report. The aircraft's DFDR records time intervals precisely, however its time base was determined to be ten seconds behind GMT. Any examination of raw DFDR data therefore needs to have ten seconds added to the recorded aircraft GMT. Timing correlation between the CVR and DFDR is less precise and in some cases, errors of up to approximately plus or minus three seconds in the CVR timing were experienced.

2. Several non mandatory items shown in the raw DFDR print out were, in fact, not recorded or were recorded erroneously. These include, gross weight and CG position, left wheel brake pedal position, ground proximity warning and autothrottle speed control. The Flight Data Acquisition Unit (FDAU) column's significance could not be satisfactorily explained by the Douglas Aircraft Co. representative or the NTSB. It is believed to be an internal computer check of the bit sampling rate from the number one FDAU.

General:

The CVR transcript starts at 0017:00 hours and covers the last 32:50 minutes of the flight. At this stage the aircraft is in cruising flight at FL 330. The last items of the descent checklist are being called by the flight engineer who reminds the pi8lots to set their altimeters through the transition altitude.

Although some 25 hours of DFDR data is available, only the last 41 minutes were read; starting with the aircraft at its cruising altitude of FL 330. The quality of the readout is excellent with very little 'bit' loss and with the loss of synchronisation only occurring at the tape splices and impact points. The breakage of the tape in 2 places at impact caused some problems, however following a bit dump and manual rearranging of the raw data all the available information was recovered. The isolated loss of information at the tape fractures is not significant and does not affect the overall readout.

Except for the last few seconds of flight (discussed later) the aircraft is flown with the number 2 autopilot in the command (normal 'on') position. Examination of the airspeed and No. 1 engine data show that the auto-throttles were engaged at various times. They were engaged during the approach to the accident site at 1,500 feet AMSL.

At 0017:13Z, when the aircraft is some 144 miles north of McMurdo, the Captain indicated he would start his descent a little early. This was initiated at 0018:44 by the standard practice of rotating the Rate of Descent wheel to establish a rate of descent which reached about 2900 feet per minute (fpm). As the aircraft approached the standard climb/descent speed (320 kts/.82 M) the "IAS hold" mode was engaged. The engagement of this mode caused the aircraft to hold the speed indicated, (in this case 323 kts) during changes in the aircraft's pitch attitude but precluded the authothrottles being operated in the 'speed' mode.

The flight crew had requested descent clearance to the minimum safe altitude (MSA) for the leg of 16000 feet, however they were only cleared to FL 180 by "Mac Centre". Approaching FL 180 the 'Vert speed' mode was engaged to reduce the rate of descent and at 0025:10 the flight guidance system automatically levelled the aircraft at FL 180. Throughout this period the aircraft had been in the 'Nav track' mode; tracking along the direct Hallett to McMurdo track with a grid heading of 358-359 degrees.

At 0031:01 the Captain sighted a hole in the cloud cover which extended to ground level but the left of track. He stated his intention to do an orbit to get below the cloud. The co-pilot and possibly an engineer indicated

that it was not clear to the right of the track. Further descent clearance was sought from "Mac Centre" and approved; and the aircraft continued descending, VMC, in an orbit approximately 43 miles north of McMurdo.

The 'Nav track' mode was disengaged at 0032:05 by pulling out the "Heading select" knob and turning the aircraft with the auto-pilot. A right turn was commenced although the preceding discussion indicated it wasn't clear to the right and that the hole to ground level was on the Captain's (left) side. A further descent was started almost immediately. The Captain instructed the co-pilot to set 10000 feet in the altitude window. The altitude was armed as at 0033:01 someone read the FMA's as, 'ALT', 'Heading Select, 'VERT Speed'.

The co-pilot advised "McMurdo Centre" when they were descending through flight level 130. The pressure altitude recorded on the DFDR at the same time indicated that they had not set QNH at this stage.

A lengthy consideration was given to the sound of 3 altitude alerts at about time 0036:00. The only logical explanation is that 11000 feet was initially set in the altitude window and after the first alert this was reset to 10000 feet as the Captain had instructed. After the second "alert" the flight engineer confirmed from the FMA's that 10000 feet had been set and armed. This is also confirmed by the aircraft automatically capturing and levelling out at an indicated altitude of 10000 feet. Corresponding QNH altitude was 9400 feet.

The aircraft rolled out of the first right hand orbit on a selected heading of 344° Grid and then remained on this heading for 1 minute 20 seconds. The Captain then stated that to stay VMC he would have to do another orbit. A left had turn was then commenced.

At 0039:07 the co-pilot advised "McMurdo Centre" that they were maintaining ten thousand. The actual altitude was 9400 feet as the altimeters were still set to the standard pressure setting.

The left turn was stopped on a heading of 179° grid. On the Captain's instructions the co-pilot asked "McMurdo Centre" for a clearance to let down VMC on a grid heading of 180° and to proceed visually to McMurdo. Immediately after this approval was given a further descent was commenced.

Two thousand feet was set and armed in the flight guidance system. Someone, probably an engineer, stated 'IAS Hold', 'IAS Hold' at 0042:47 and right at this time the modes change from 'vert speed' which was used to initiate the descent to 'IAS Hold'. The air speed at the time 'IAS Hold' was selected was 272 kts.

A few seconds later when the aircraft was passing through 9300 feet the Captain stated that as "it's VMC" around his side, he was going to turn in again and immediately commenced a left turn.

While turning through a grid heading of 100° the Captain stated that he would arm the "NAV" again and immediately the roll mode annunciator changed from "Heading select" to 'NAV capture', confirming he had done this and the aircraft was within the capture zone for "Nav track". The aircraft continued to descend in the "IAS Hold" mode with an air speed of around 272 kts.

At 0044:40 the aircraft again locked onto the Hallett-McMurdo track and the FMA changed to 'NAV track'. This was not immediately announced by the crew, possibly due to the distraction caused by answering McMurdo Centre's query on the height of the cloud tops and talking to the official flight commentator who arrived in the cockpit during the aircraft's last turn.

The co-pilot advised McMurdo at 0045:00 that they were at 6,000 feet, descending to 2000 feet, VMC. At this time the aircraft was passing through an altitude of 5400 feet, confirming that QNH still had not been set on the pilots' main altimeters.

Up to this point the aircraft had been descending in the 'IAS Hold' mode with a speed of around 272 kts and a rate of descent of around 1300 to 1500 fpm. At 0045:35 the 'vert speed' mode was engaged. While this was an acceptable procedure to reduce the rate of descent as the assigned altitude approached, in this case the rate of descent increased and IAS built up to a maximum of 303 kts at 3500 feet QNH. The engine N_1

speeds during this manoeuvre were at the flight idle speed of about 42%. This manoeuvre may have been necessary to keep clear of cloud.

In response to a statement "altimeters" by some unidentified person, the Captain reset his altimeter to the correct QNH as the aircraft passed through 4000 feet indicated altitude. The co-pilot announced "a thousand to go" as they passed through 3000 feet QNH confirming both pilots altimeters were then set to QNH.

At 0046:25 the Captain called 'Speed' as he set 260 kts, which had previously been calculated and agreed to, in the autothrottle speed command window. The autothrottles held the engines at a low power setting until this speed was reached then power was reapplied to hold the selected speed.

The altitude alert sounded 750 feet above the set altitude and the aircraft automatically levelled off at 2000 feet. The FMA's showed an 11 second gap between the time "altitude hold" was displayed and vert speed was selected for a further descent following the Captain's comment that he would further descend to 1500 feet. The DFDR readout showed the aircraft level at 2000 feet for about the same period. A very short period was spent at the nominated lower limit altitude of 2000 feet before the Captain stated "We might have to pop down to 1500 feet here I think". This is supported by the co-pilot's agreement in his comment "Yes. Probably see further in anyway", comments by the flight engineer of "You're really a long while on instruments at this time" and comments from other unidentified persons of "bit thick here", - "What's wrong here" – "Make up your mind you got to go" .....

McMurdo Centre was not advised of the descent to 1500 feet.

The FMA displayed "Alt hold" at 0048:23 when the aircraft was at 1515 feet. One unusual aspect of the level off at 1500 feet was that it was not as precise as other automatic level offs portrayed by the DFDR. Over the next 25 seconds the aircraft continued a slow descent to a minimum altitude of 1443 feet, then it commenced a slow climb to reach a maximum altitude of 1540 feet, 17 seconds before impact. Both are minor deviations in selected altitude.

The final approach to the accident site was with the autothrottles in the "Speed" mode with 260 kts commanded. The roll mode was selected to "Nav track" with the aircraft maintaining a grid heading of 357-358 degrees; the pitch mode was selected to "Alt hold" with 1500 feet commanded.

Passage over the ice cliffs on the edge of Ross Island is noted by a reduction of 270 feet in 1.5 seconds on the radio altitude readout. This occurred 11 seconds prior to impact, which was exactly the timing achieved during later trials in the DC 10 flight simulator. The average radio altitude descent rate as the aircraft flew towards the slope was 6300 fpm. The GPWS warning commenced in the half second between radio altitude samplings of 637 feet and 583 feet. In the simulator the GPWS warning commenced at 610 feet. The flight engineer's calls of "500 feet" and "400 feet" radio altitude were almost at identical times to those noted during the simulator exercise.

A study of the vertical acceleration data which is sampled 8 times a second showed that the aircraft experienced no significant turbulence or downdraughts during the later stages of the flight. The vertical acceleration trace reached a maximum value of plus 1.67 G two seconds before impact. This is associated with a pitch up of the aircraft some 2.5 seconds before impact from a level flight altitude of 5° nose up to a maximum of 10.9° nose up.

No change in altitude is recorded as a result of this pitch up although the NCU memory recorded a plus 10 fps vertical acceleration at impact.

This pitch up resulted from a sudden (7° in 2 seconds) application of nose up elevator, 4 seconds prior to impact. The discrete data for the auto-pilot (which in this particular area contains some doubtful information as the result of the tape break) indicates that the No. 2 auto-pilot was disengaged 4 seconds prior to impact. A sudden elevator input will cause the auto-pilot to disengage and it appears that this is what happened as the crew reacted to the "pull up" warning from the GPWS.

A small but significant increase in the longitudinal acceleration (which is sampled 9 times a second) was noted in the last 2 seconds of the flight. This acceleration was due to the application of engine power. No increase in air speed had been registered.

Eight seconds prior to impact and 2 seconds before the GPWS warning started, the roll mode FMA changed from 'NAV Track' to 'Heading Select' as the 'Heading Select' knob was pulled out. This would be done to turn the aircraft through the auto-pilot and followed a discussion by the pilots on which way to turn to get out of their present position. The co-pilot said "it's clear to turn to the right" but the Captain contradicted him. Immediately the 'Heading Select' knob was pulled out the aircraft commenced to roll to the right. This right roll which was also evidenced by the movement of ailerons and spoilers which reached a maximum of 11° bank 3.5 seconds before impact. The roll was then reversed, as the pilot attempted to commence a left turn. This reverse roll which was the result of control surface movement, results in the aircraft striking the ground while rolling left through a wings level attitude. These rolling manoeuvres had no significant effect on the aircraft heading which was last recorded as 358.95° grid.

In the last 3.5 seconds of flight there was a sudden large application of left rudder of some three degrees which rapidly increases to reach a maximum of 13 degrees left rudder angle just prior to impact. A study of the last 40 minutes of flight showed that the auto-pilot in the 'Heading Select' mode only applied the maximum of 1 degree of rudder for very short periods. This rudder input was thus applied manually. This rudder application resulted in a small change in lateral acceleration and skidding of the aircraft.

One of the pilot's FMAs was recovered from the wreckage and was examined by the Douglas Aircraft Company to determine the modes being displayed at impact. This confirmed the information on mode status being displayed at impact. This confirmed the information on mode status obtained from the DFDR namely:

Autothrottle mode	-	Speed
Armed mode	-	Nil
Roll mode	-	Heading Select
Pitch mode	-	Altitude Hold

Conclusions

The following conclusions are derived from a detailed study of the DFDR data in conjunction with analysis of the CVR Tape:

Throughout the last 40 minutes of flight the aircraft was airworthy and capable of normal operation.

The aircraft encountered no atmospheric conditions such as turbulence or downdraught which in any way contributed towards the cause of this accident.

The navigational and flight guidance systems performed normally. The number 2 auto-pilot flew the aircraft through all but the last seconds of flight when it was disengaged during the recovery manoeuvre.

The flight crew did not set their main altimeters to the McMurdo QNH until the aircraft had descended below 4,000 feet indicated altitude.

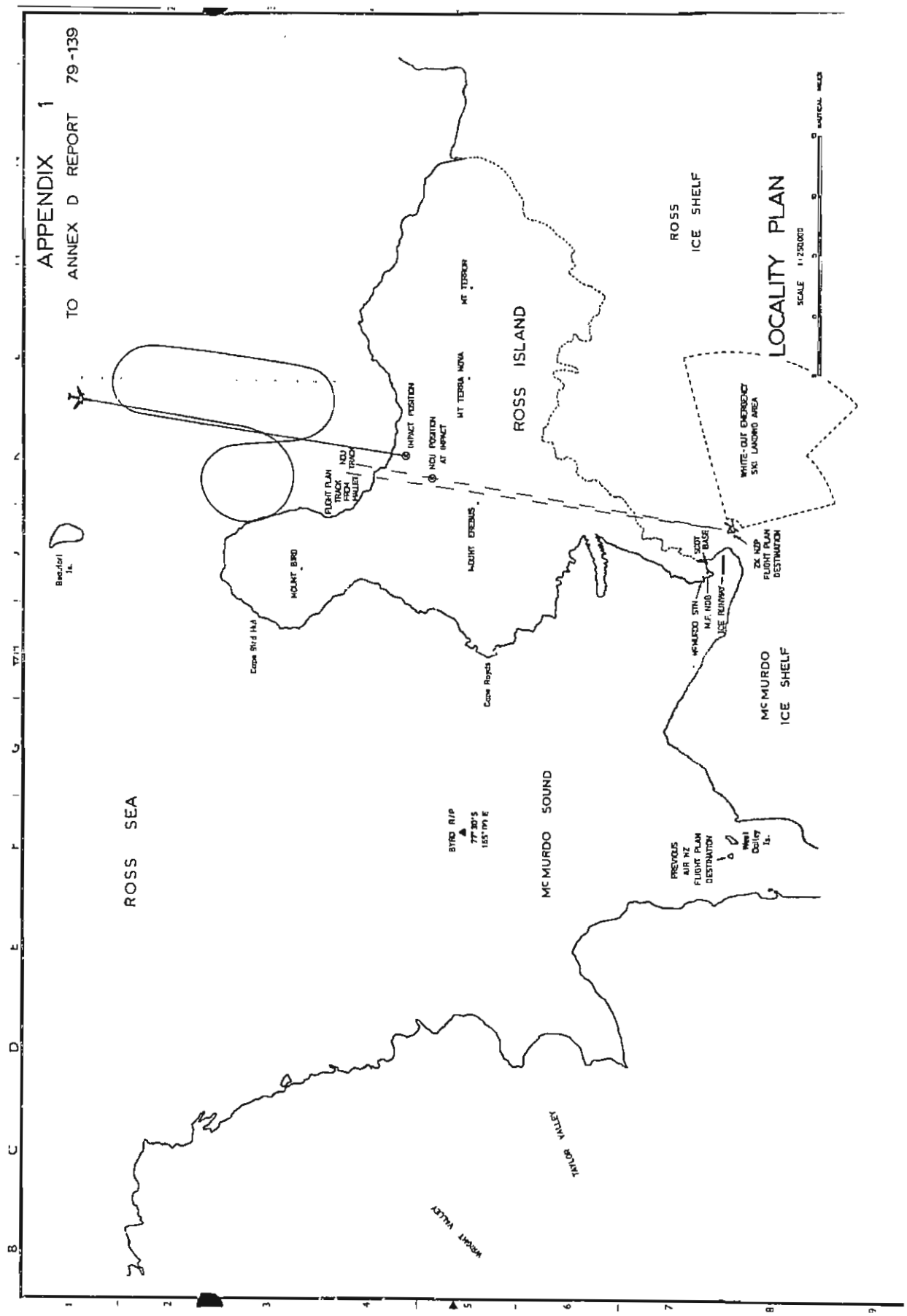
Action had been taken to turn the aircraft prior to the GPWS warning soundings.

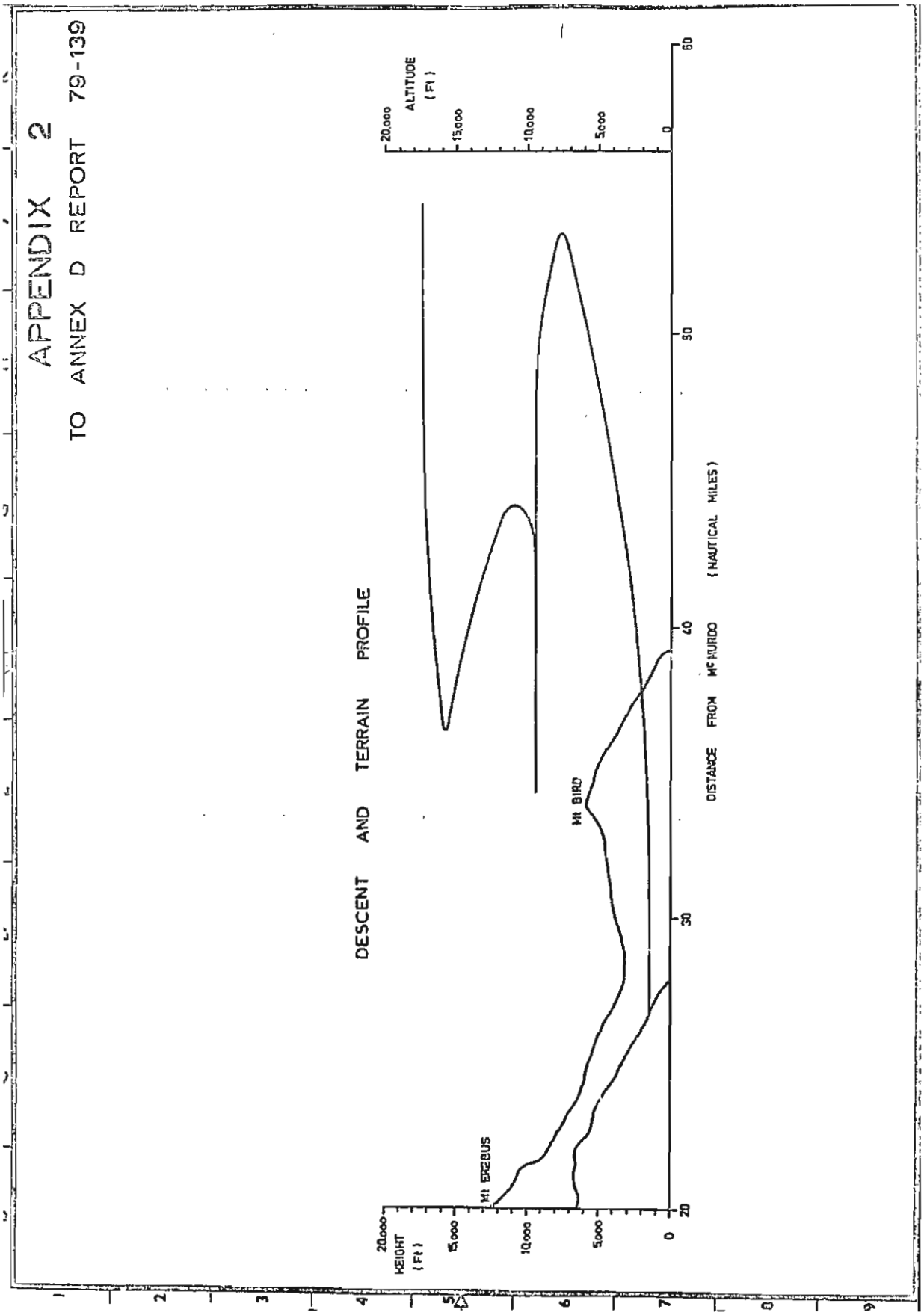
The GPWS operated within its design parameters and provided 6.5 seconds of warning.

The crew responded expeditiously in the circumstances to the GPWS warning. Simulator trials proved conclusively that with an unexpected warning such as this, it would have been impossible to avoid the accident with a normal pilot's response allowing reasonable identification and reaction times to the GPWS warning.

The aircraft had barely commenced to respond to the avoidance manoeuvres and power application prior to impact.

The DRDR and CVR tape transport modules were undamaged in the extensive disintegration of the aircraft at impact. The DFDR provided an excellent record and the CVR record was of the standard expected when the main input was from the cockpit area microphone. The two recorders were extremely valuable in providing the essential basic information for a detailed investigation of this accident.


APPENDIX 1
TO ANNEX D REPORT 79-139
LOCALITY PLAN
SCALE 1:250000
ROSS ISLAND
ROSS ICE SHELF
ROSS SEA
McMURDO SOUND
McMURDO ICE SHELF
MOUNT BIRD
MOUNT EREBUS
MT TERROR
MT TERRA NOVA
Cape Bird
Cape Royds
Beaufort Is.
Ross Is.
BYRD R/P
77° 30'S
155° 19' E
McMURDO STN
SCOTT BASE
N.Z. HOSP
ICE RUNWAY
PREVIOUS AIR NZ FLIGHT PLAN DESTINATION
2K HOSP FLIGHT PLAN DESTINATION
WHITE-OUT EMERGENCY SKI LANDING AREA
FLIGHT PLAN TRACK
NDU TRACK
IMPACT POSITION
NDU POSITION AT IMPACT
WRIGHT VALLEY
TAYLOR VALLEY


APPENDIX 2
TO ANNEX D REPORT 79-139
DESCENT AND TERRAIN PROFILE
ALTITUDE (Ft)
20,000
15,000
10,000
5,000
0
HEIGHT (Ft)
Mt EREBUS
Mt BIRD
DISTANCE FROM McMURDO (NAUTICAL MILES)
0
10
20
30
40
50
60

APPENDIX 3

TO ANNEX D REPORT 79-139

EXTRACTS FROM THE COCKPIT VOICE RECORDER OF ZK-NZP

A. I'LL HAVE TO DO AN ORBIT HERE I THINK (CAM-1)

B. WELL ACTUALLY ITS CLEAR OUT HERE IF WE CAN GET DOWN (CAM 1)

C. IT'S NOT CLEAR ON THE RIGHT HAND SIDE HERE (CAM-1)

D. WE'D LIKE FURTHER DESCENT OR WE COULD ORBIT 76 OUR PRESENT POSITION WHICH IS APPROXIMATELY 43 MILES AGAIN DESCENDING VMC, (RDO 2)

E. I'LL DO AN ORBIT HERE TO GET DOWN I THINK (CAM 1)

F. WE ARE PRESENTLY DESCENDING THROUGH FLIGHT LEVEL 130 VMC AND THE INTENTION AT THE MOMENT IS TO DESCEND TO 10000 (RDO 2)

G. TRANSPONDER NOW RESPONDING (CAM 2)

H. WE'VE LOST HIM AGAIN (CAM-2)

I. YOU'RE THROUGH 10000 ARE YOU GOING TO HOLD IT HERE? (CAM-4)

J. I'VE GOT TO STAY VMC HERE SO I'LL BE DOING ANOTHER ORBIT (CAM-1)

K. WE'RE MAINTAINING 10000 PRESENTLY 34 MILES TO THE NORTH OF McMURDO (RDO-2)

L. STILL NEGATIVE CONTACT ON VHF WE'RE VMC - WE'D LIKE TO LET DOWN ON A GRID OF 180 AND PROCEED VISUALLY TO McMURDO (RDO-2)

M. WELL WE'RE JUST GOING VMC TO McMURDO AND THEN COME BACK IN (CAM-1)

N. WE'RE VMC AROUND THIS WAY SO I'M GOING TO DO ANOTHER TURN IN (CAM-1)

O. YOU CAN'T TALK IF YOU CAN'T SEE ANYTHING (CAM-5)

P. THERE YOU GO THERE'S SOME LAND AHEAD (CAM-5)

Q. I'LL RAH THE WAY AGAIN (CAM-1)

R. ALT, NAV CAP, TAS HOLD (CAM-1)

S. WE ARE NOW AT 6000 DESCENDING TO 2000 AND WE'RE VMC (RDO-2)

T. WE HAD A MESSAGE FROM THE WRIGHT VALLEY AND THEY'RE CLEAR OVER THERE (CAM-1)

U. THE TAYLOR OR THE WRIGHT NOW OR DO YAY (CAM-5) NO - I PREFER HERE FIRST (CAM-1)

V. I STILL CAN'I SEE VERY MUCH AT THE MOMENT - AS SOON AS I SEE SOMETHING THAT GIVES ME A CLUE AS TO WHERE WE ARE I'LL LET YOU KNOW (CAM-5)

W. ALTIMETERS (CAM-3)

X. 29 - 29.30 (CAM-3)

Y. ALT, NAV TRACK, VERT SPEED (CAM-2)

Z. WHERE'S EREBUS IN RELATION TO US AT THE MOMENT? (CAM-3) LEFT ABOUT (TWENTY) OR (TWENTY) 5 MILES (?) LEFT DO YA RECKON (?) - WELL ; DON'T KNOW ; THINK (?) I'VE BEEN LOOKING FOR IT (?) I THINK IT'LL BE (?) I'D JUST THINKING OF ANY HIGH GROUND IN THE AREA THAT'S ALL (CAM 3)

AA. THAT'S THE EDGE (CAM-5)

BB. WE MIGHT HAVE TO POP DOWN TO 1500 HERE I THINK (CAM-3) PROBABLY SEE FURTHER IN ANYWAY (CAM-2)

CC. BIT THICK HERE EH (BERT)? YES MY [illegible] OATH! (CAM 6)

DD. YOU'RE REALLY A LONG TIME ON [illegible] INSTRUMENTS AT THIS TIME AREN'T YOU? (CAM-4)

EE. I RECKON BIRD'S THROUGH HERE ... AND POSS ISLAND'S THERE ... EREBUS SHOULD BE HERE (CAM-5)

FF. ALT HOLD (CAM-7)

GG. ACTUALLY THOSE CONDITIONS DON'T LOOK VERY GOOD AT ALL DO THEY (CAM-3) NO THEY DON'T (CAM-5)

HH. THAT LOOKS LIKE THE EDGE OF ROSS IS. THERE (CAM-5)

II. I DON'T LIKE THIS (CAM-3)

JJ. WE'RE 26 MILES NORTH I'LL HAVE TO CLIMB OUT OF THIS! (CAM-3)

KK. IT'S CLEAR TO THE RIGHT AND (WELL) AHEAD - YOU'RE CLEAR TO TURN RIGHT THERE'S NO HIGH GROUND IF YOU DO A 360 (CAM-2) DO - NEGATIVE (CAM-3)

LL. (GPWS) MOOP-MOOP PULL UP MOOP-MOOP

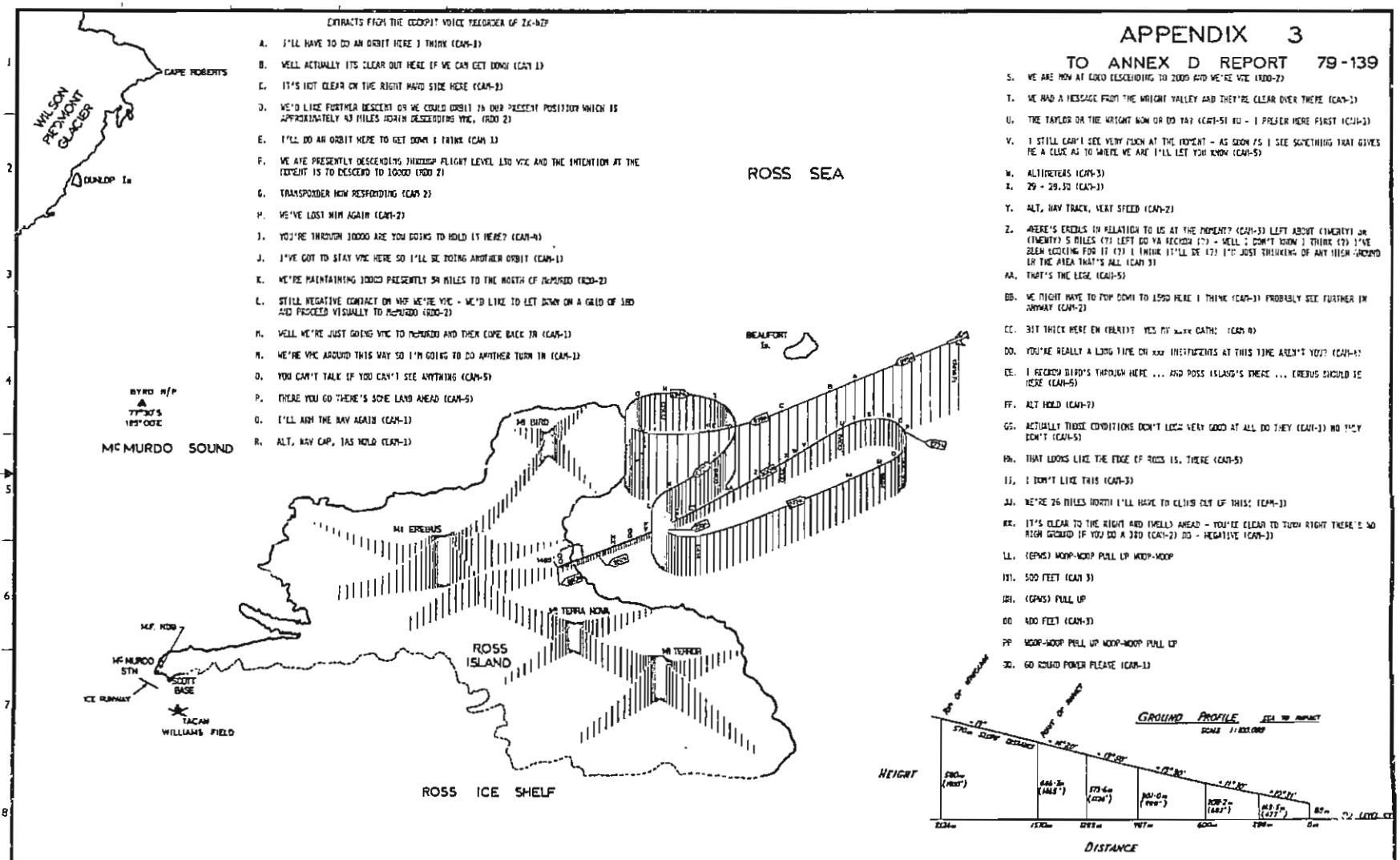
MM. 500 FEET (CAM 3)

NN. (GPWS) PULL UP

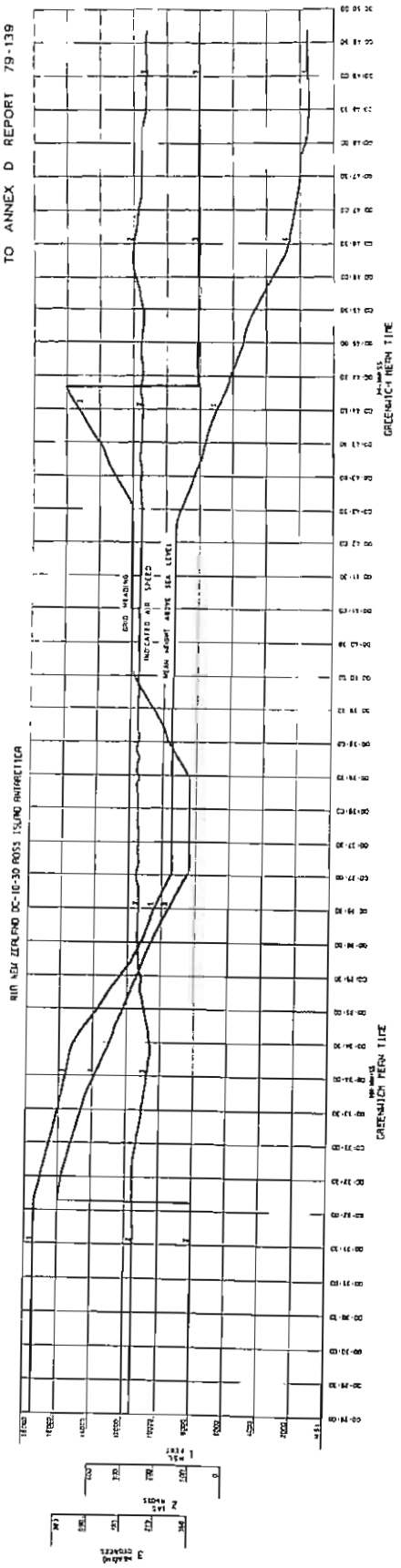
OO 400 FEET (CAM-3)

PP MOOP-MOOP PULL UP MOOP-MOOP PULL UP

QQ. GO ROUND POWER PLEASE (CAM-1)



APPENDIX 4
TO ANNEX D REPORT 79-139

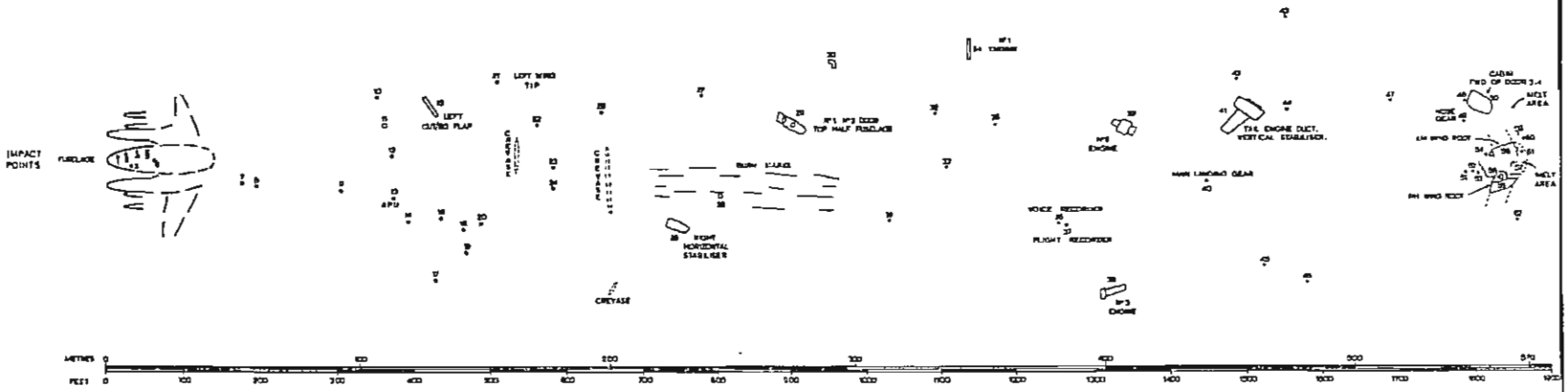


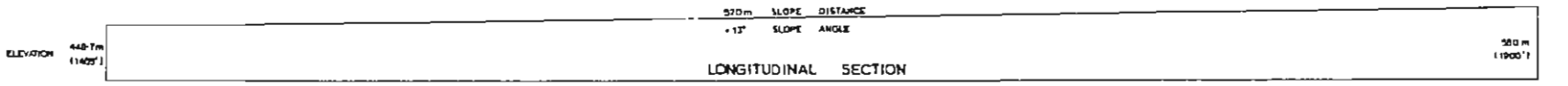
ANNEX E
TO REPORT 79-139

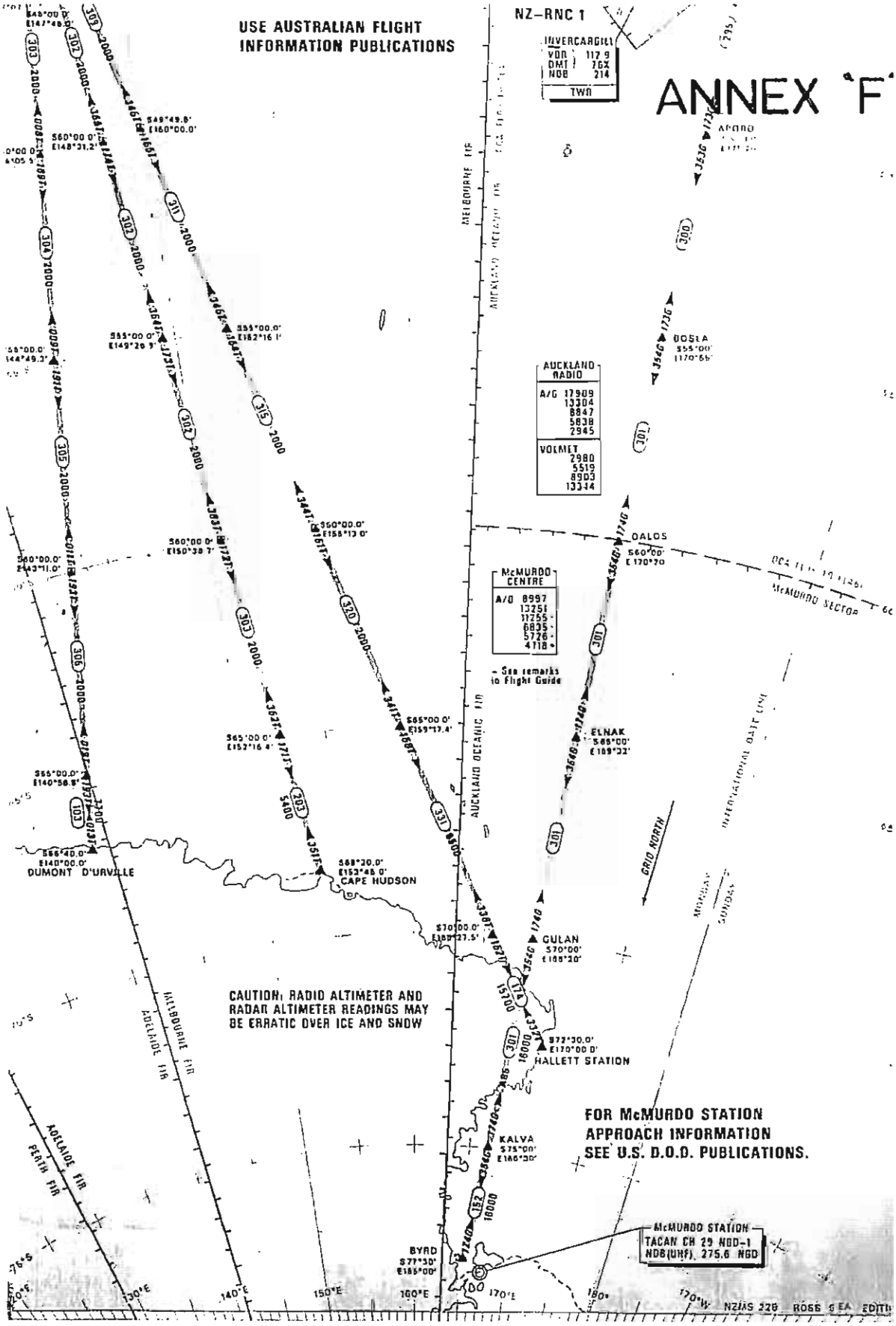
KEY TO SITE PLAN OF WRECKAGE ZK-KEP

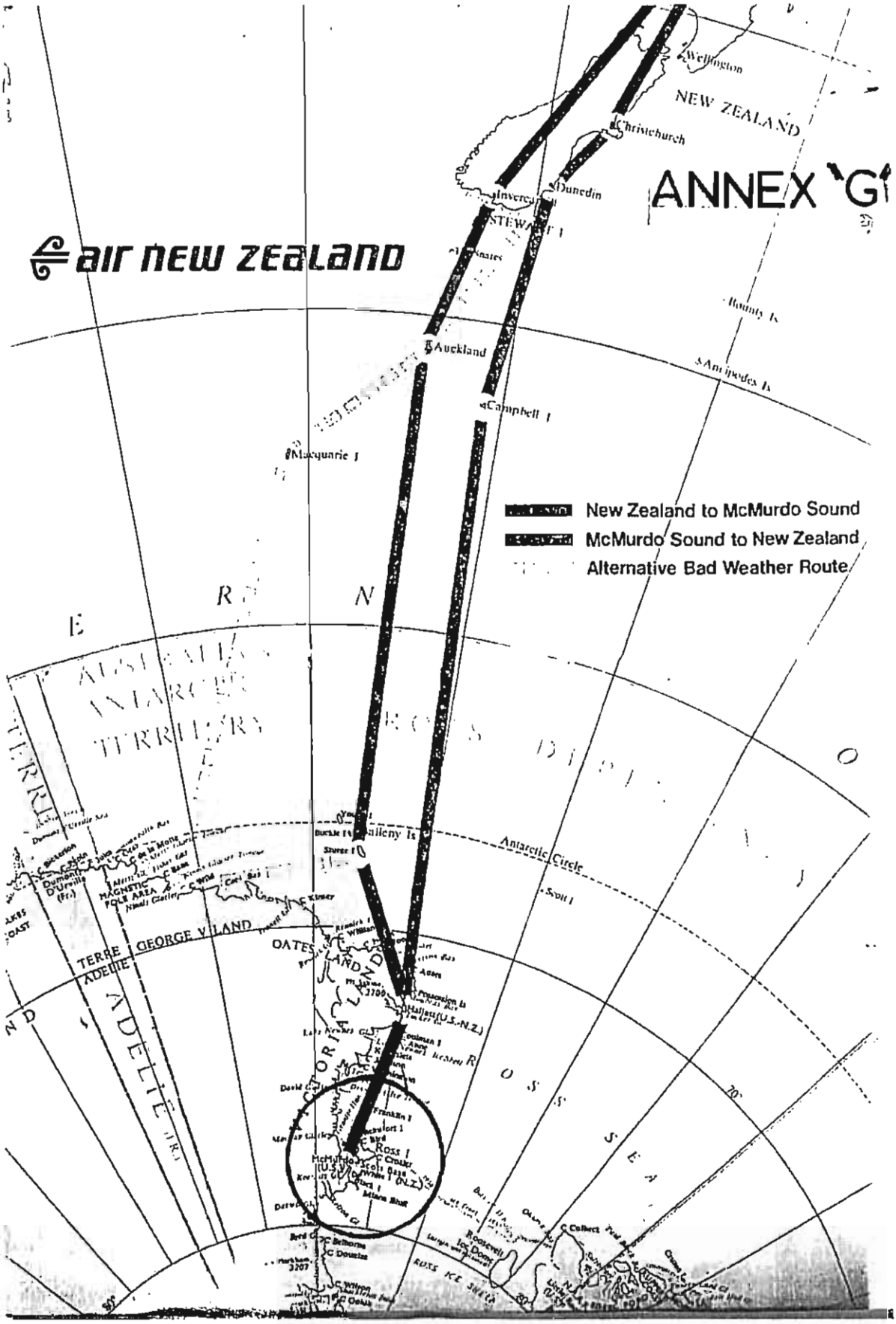
NO.	ITEM
1.	OUTSIDE SKIN STRUCTURE
2.	REAR TOILET DRAIN ACCESS PANEL
3.	DRAIN MAST
4.	APU DOOR FRAME
5.	BULK CARGO DOOR
6.	EXPOSED LOWER WING SECTION STRUCTURE
7.	TURBINE DISC
8.	TAILCONE LOWER ACCESS DOOR
9.	OUTBOARD AILERON
10.	MAIN GEAR DOOR
11.	LEFT STABILISER
12.	OUTBOARD ELEVATOR
13.	APU
14.	LEADING EDGE SLAT
15.	LEFT OUTBOARD FLAP
16.	ENGINE LOW PRESSURE TURBINE
17.	OUTBOARD ELEVATOR
18.	7 on 8 L/E SLAT
19.	HIGH PRESSURE TURBINE DISC
20.	RH L/E SLAT
21.	LEFT WING TIP
22.	ENGINE CASING L/P TURBINE
23.	UPPER TAILCONE PLATFORM
24.	TAILCONE
25.	H/P TURBINE
26.	RH HORIZONTAL STABILISER
27.	FAN ROTOR
28.	INBOARD ELEVATOR
29.	TOP HALF FUSELAGE No 1 & No 2 DOOR
30.	FAN CASE
31.	MAIN WHEEL WELL STRUCTURE
32.	ENGINE COMPRESSOR STATOR
33.	FAN CASE
34.	No 1 ENGINE
35.	COOLING TURBINE
36.	COCKPIT VOICE RECORDER
37.	FLIGHT DATA RECORDER
38.	No 3 ENGINE
39.	No 2 ENGINE
40.	MAIN LANDING GEAR
41.	TAIL ENGINE DUCT/VERTICAL STABILISER
42.	MAIN LANDING GEAR AXLE
43.	AXLE ASSEMBLY
44.	SEATS
45.	FAN CASE/FAN SPEED SENSOR
46.	FORWARD MAIN AXLE
47.	CENTRE MAIN LANDING GEAR
48.	FLIGHT DECK
49.	NOSE GEAR
50.	CABIN FORWARD OF DOOR 3 & 4
51.	VIEW WINDOW
52.	HYDRAULIC GEAR
53.	FLOOR ABOVE GEAR
54.	INBOARD AILERON
55.	RH WING ROOT
56.	DOOR 6
57.	DOOR 5
58.	LH WING ROOT
59.	L/E SLAT
60.	WING STRUCTURE
61.	CABIN SIDE
62.	WING STRUCTURE

SITE PLAN

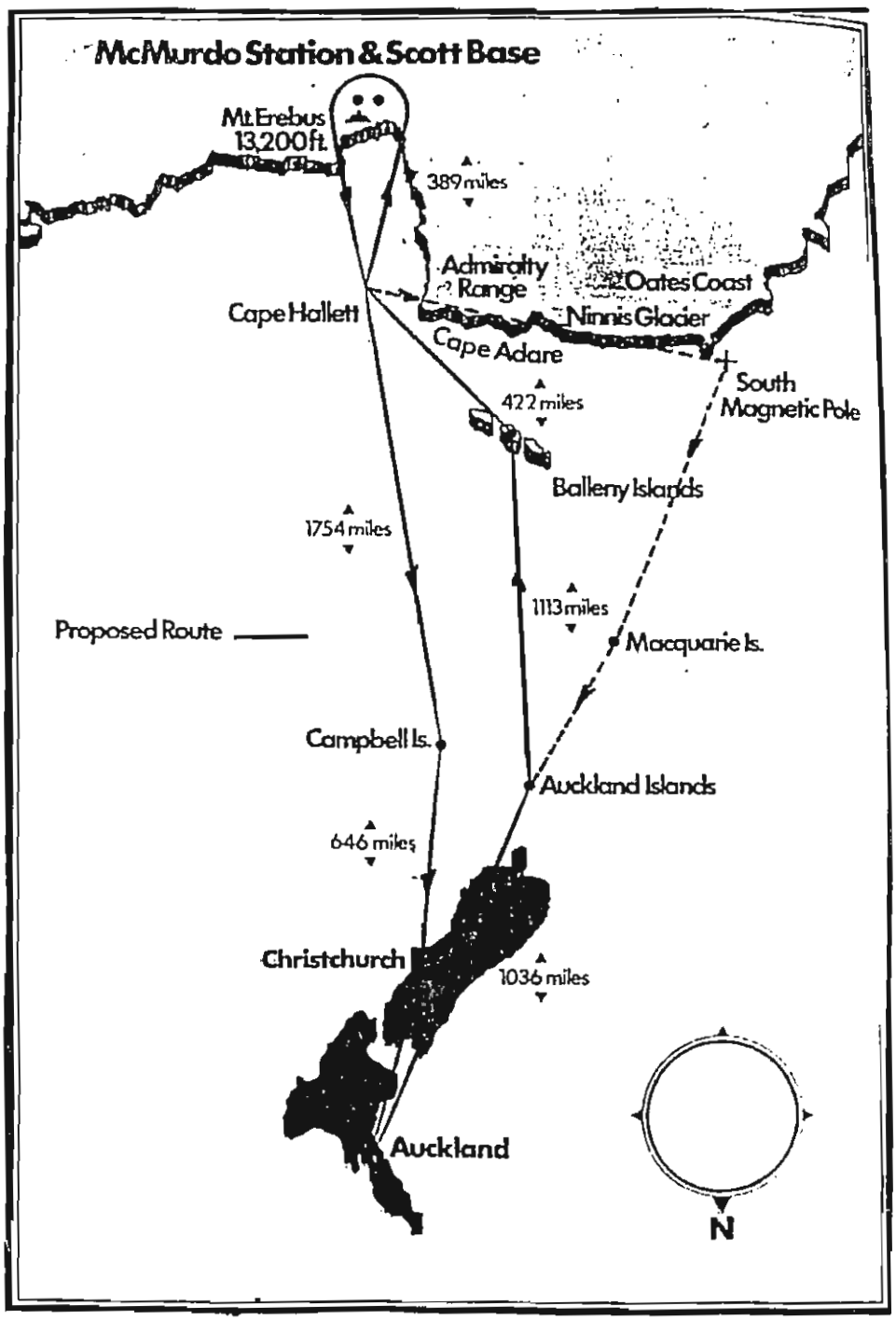


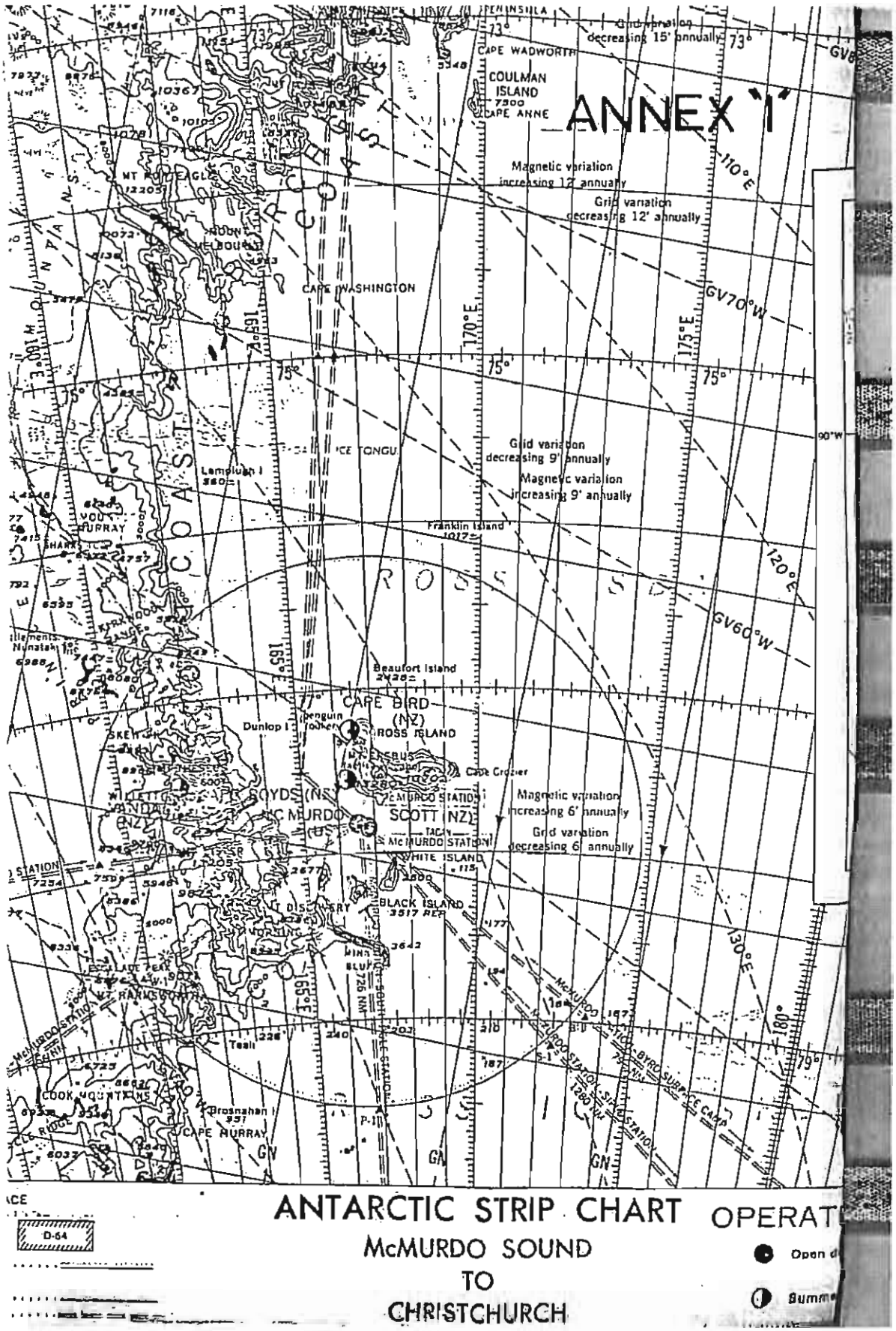


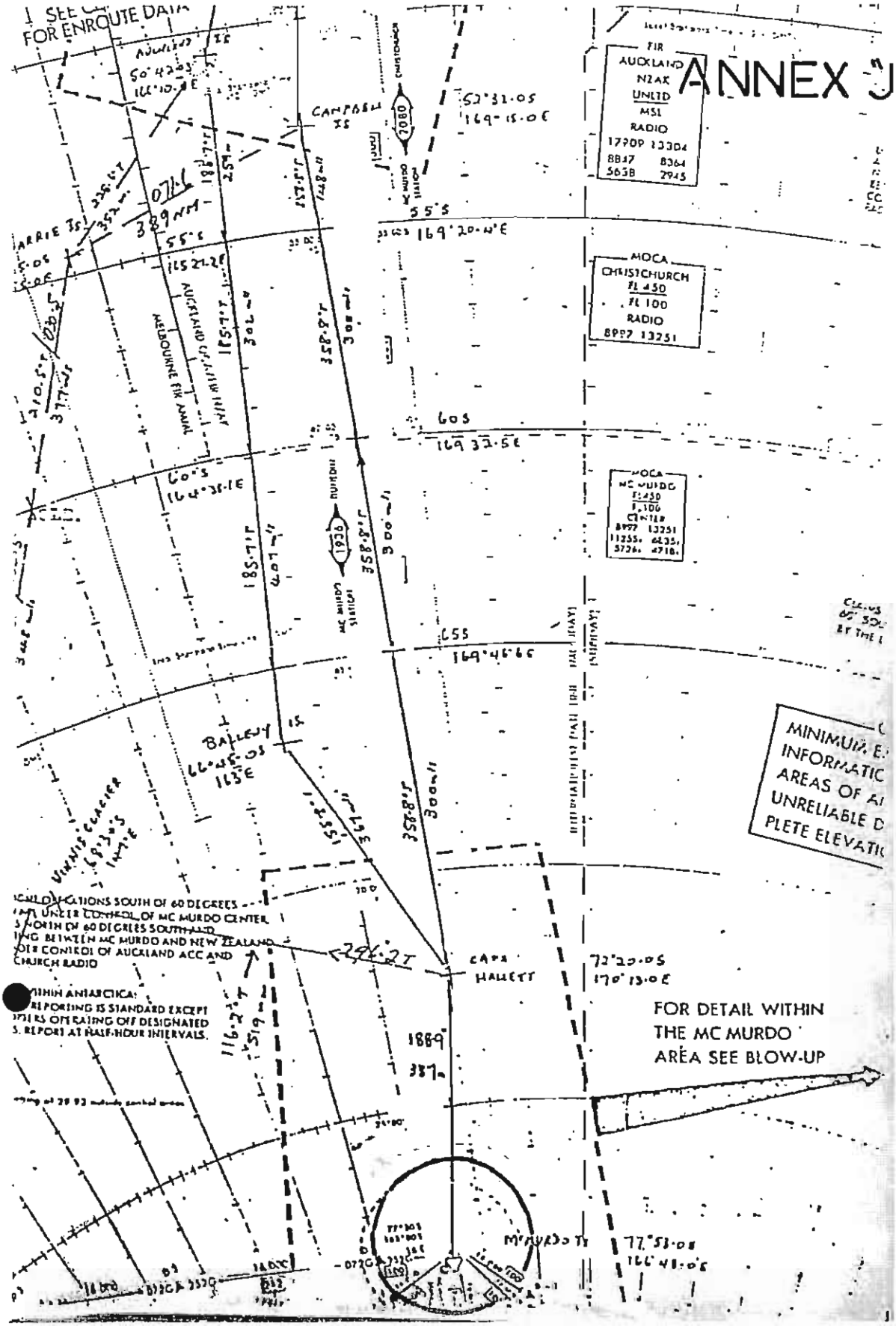

ANNEX 'F'
NZ–RNC 1
USE AUSTRALIAN FLIGHT INFORMATION PUBLICATIONS
INVERCARGILL
VOR 117.9
DME 76X
NDB 214
TWR
AUCKLAND RADIO
A/G 17909
13304
8847
5838
2945
VOLMET
2980
5519
8903
13344
McMURDO CENTRE
A/D 8997
13251
11755 *
6835 *
5726 *
4118 *
* See remarks in Flight Guide
AUCKLAND OCEANIC FIR
MELBOURNE FIR
ADELAIDE FIR
PERTH FIR
DUMONT D'URVILLE
CAPE HUDSON
OALOS
ELNAK
GULAN
HALLETT STATION
KALVA
BYRD
GRID NORTH
CAUTION: RADIO ALTIMETER AND RADAR ALTIMETER READINGS MAY BE ERRATIC OVER ICE AND SNOW
FOR McMURDO STATION APPROACH INFORMATION SEE U.S. D.O.D. PUBLICATIONS.
McMURDO STATION
TACAN CH 29 NDB-1
NDB(UHF) 275.6 NBD
NZIAS 228 ROSS SEA EDITION


air new zealand
ANNEX 'G'
New Zealand to McMurdo Sound
McMurdo Sound to New Zealand
Alternative Bad Weather Route
Wellington
NEW ZEALAND
Christchurch
Dunedin
Auckland
Campbell I
Macquarie I
Antipodes Is
Antarctic Circle
TERRE ADELIE
GEORGE V LAND
OATES LAND
ROSS SEA
ROSS ICE SHELF
Scott I
Hallett (U.S.-N.Z.)
Cape Adare
Cape Crozier
Cape Bird
Cape Bernacchi
Cape Wilson
Cape Oates
Cape Colbeck
Roosevelt I
Ice Doom
Franklin I
Coulman I
Balleny Is
Sturge I
Possession Is
Darwin Glacier
Mt Lister
Mt Northampton
Mt Dockery
Mt Minto
Mt Sidley
Mt Waesche
Mt Siple
Mt Rea
Mt Hampton
Mt Rees
Mt Gardner
Mt Murphy
Mt Nash
Mt Hunter
Mt Gilbert
Mt Bowers
Mt Kirkpatrick
Mt Lucas
Mt Markham
Mt Minshew
Mt Weaver
Mt Wade
Mt Bastien
Mt Gauss
Mt Ruppert
Mt Hall
Mt Hooker
Mt Dickerson
Mt Dickey
Mt Bowman
Mt Gran
Mt Lowe
Mt Kaplan
Mt Ward
Mt Ferrar
Mt Bird
Mt Discovery
Mt Terror
Mt Erebus
Mt Melbourne
Mt Rittmann
Mt Baker
Mt Sabine
Mt Adams
Mt Monteagle
Mt Lister
Mt Northampton
Mt Dockery
Mt Minto
Mt Sidley
Mt Waesche
Mt Siple
Mt Rea
Mt Hampton
Mt Rees
Mt Gardner
Mt Murphy
Mt Nash
Mt Hunter
Mt Gilbert
Mt Bowers
Mt Kirkpatrick
Mt Lucas
Mt Markham
Mt Minshew
Mt Weaver
Mt Wade
Mt Bastien
Mt Gauss
Mt Ruppert
Mt Hall
Mt Hooker
Mt Dickerson
Mt Dickey
Mt Bowman
Mt Gran
Mt Lowe
Mt Kaplan
Mt Ward
Mt Ferrar
Mt Bird
Mt Discovery
Mt Terror
Mt Erebus
Mt Melbourne
Mt Rittmann
Mt Baker
Mt Sabine
Mt Adams
Mt Monteagle

ANNEX 'H'


McMurdo Station & Scott Base
Mt Erebus
13,200 ft.
389 miles
Admiralty
Range
Oates Coast
Cape Hallett
Ninnis Glacier
Cape Adare
South
Magnetic Pole
422 miles
Balleny Islands
1754 miles
1113 miles
Proposed Route
Macquarie Is.
Campbell Is.
Auckland Islands
646 miles
Christchurch
1036 miles
Auckland
N


ANNEX "I"
ANTARCTIC STRIP CHART
McMURDO SOUND
TO
CHRISTCHURCH
Magnetic variation increasing 12' annually
Grid variation decreasing 12' annually
Grid variation decreasing 15' annually
Grid variation decreasing 9' annually
Magnetic variation increasing 9' annually
Magnetic variation increasing 6' annually
Grid variation decreasing 6' annually
CAPE WADWORTH
COULMAN ISLAND
CAPE ANNE
CAPE WASHINGTON
ICE TONGUE
Franklin Island
Beaufort Island
CAPE BIRD (NZ)
ROSS ISLAND
Cape Crozier
McMURDO STATION
SCOTT (NZ)
McMURDO (US)
WHITE ISLAND
BLACK ISLAND
Dunlop I
Lamplugh I
CAPE MURRAY
Brosnahan I
COOK MOUNTAINS
Teall
D-64
Open
Summ
110°E
120°E
130°E
170°E
175°E
180°
90°W
GV70°W
GV60°W
75°
77°


ANNEX J
FOR ENROUTE DATA
FIR
AUCKLAND
NZAX
UNLTD
MSL
RADIO
17909 13304
8847 8364
5638 2945
MOCA
CHRISTCHURCH
FL 450
FL 100
RADIO
8997 13251
MOCA
MC MURDO
FL450
FL100
CENTER
8997 13251
11355 6435
5726 4918
MELBOURNE FIR ANVAL
AUCKLAND OCEANIC FIR
MC MURDO STATION
BAILEY
CAPE HALLETT
MINIMUM E
INFORMATIC
AREAS OF A
UNRELIABLE D
PLETE ELEVATI
FOR DETAIL WITHIN
THE MC MURDO
AREA SEE BLOW-UP
UNDER CONTROL OF MC MURDO CENTER
NORTH OF 60 DEGREES SOUTHBOUND
BETWEEN MC MURDO AND NEW ZEALAND
OLER CONTROL OF AUCKLAND ACC AND
CHURCH RADIO
REPORTING IS STANDARD EXCEPT
RS OPERATING OFF DESIGNATED
REPORT AT HALF-HOUR INTERVALS.

Annex K
to Report 79-139

98.4.76

CA 1333

DEPARTMENT OF CIVIL AVIATION NEW ZEALAND

AIR TRANSPORT FLIGHT INSPECTION REPORT

NAME OF OPERATOR:	FLIGHT NUMBER:
Air New Zealand	TE9012

DEPARTURE

TIME:	DATE:
0800	15.2.77

ROUTE

FROM	TO
AUCKLAND	CHCH

EN ROUTE STOPS: IA ANTARCTICA

AIRCRAFT

TYPE:	REGISTRATION:
DC10	ZK-NZN

FLIGHT CREW	RANK	CABIN CREW	RANK
1. GEMMELL	CAPT	1.	
2. LAWSON	CAPT	2.	
3. SINCLAIR	F/O	3.	
4. AMIES	N/O	4.	
5. ROBERTSON	E/O	5.	
6. OLLIFF	E/O	6.	
7.		7.	

FLIGHT TIMES	TOTAL:	DAY:	NIGHT:
	11.00	11.00	--

ACTUAL I/F:	SIMULATED I/F:
.35	

EN ROUTE INSPECTION CHECK LIST

ITEM	SAT	UNSAT
PRE-FLIGHT		
1. WEATHER ANALYSIS	X	
2. FLIGHT PLANNING	X	
3. TAKE-OFF WEIGHT AND BALANCE DATA	X	
4. TAKE-OFF PERFORMANCE CALCULATIONS	X	
5. FIRST OFFICER'S PRE-FLIGHT	X	
6. FLIGHT ENGINEER'S PRE-FLIGHT	X	
DEPARTURE		
7. STARTING PROCEDURE	X	
8. TAXYING	X	
9. CLEARANCE RECORD AND READ BACK	X	
10. TAKE-OFF GROSS WEIGHT (242000 kgs)	X	
11. POWER CHECK	X	
12. V_1 V_R V_2 COMPLIANCE	X	
13. TAKE-OFF CLIMB	X	
14. NOISE ABATEMENT PROCEDURE	NA	
15. ADHERENCE TO CLEARANCE	X	
EN ROUTE		
16. USE OF AIRBORNE RADAR	X	
17. FUEL HANDLING	X	
18. APPRECIATION OF WEATHER SYSTEM	X	
19. HANDLING OF ABNORMALITIES	NA	
20. HANDLING OF EMERGENCIES	NA	
21. AIRCRAFT DISCREPANCIES LOGGED	X	
APPROACH AND LANDING		
22. LANDING WEIGHT (153,000 kgs)	X	
23. ADHERENCE TO CLEARANCE	X	
24. APPROACH SPEEDS	X	
25. LANDING TECHNIQUE	X	
INSTRUMENT FLIGHT		
26. HEADING CONTROL	X	
27. ALTITUDE CONTROL	X	
28. SPEED CONTROL	X	
TYPE OF APPROACH		
29. ☒ ILS ☐ PAR ☐ VOR ☐ NDB ☐ OTHER		
30. ADHERENCE TO HOLDING PROCEDURE	NA	
31. ADHERENCE TO APPROACH PROCEDURE	X	
32. ADHERENCE TO MINIMUM ALTITUDES	X	
33. MISSED APPROACH	NA	
34. TRANSITION	X	

ITEM	SAT	UNSAT
FLIGHT CREW—GENERAL		
35. LICENCE VALIDITY	X	
36. VIGILANCE	X	
37. CREW COORDINATION	X	
38. JUDGMENT (CAPTAIN)	X	
39. FLIGHT MANAGEMENT (CAPTAIN)	X	
40. COMPLIANCE WITH DCA REQUIREMENTS	X	
41. COMPLIANCE WITH A/C LIMITATIONS	X	
42. COMPLIANCE WITH FLIGHT TIME LIMITATIONS	X	
43. COMPLIANCE WITH OPERATIONS MANUAL	X	
44. FLIGHT MANUAL AND ROUTE GUIDE CHECKED	X	
45. POSITION REPORTING AND WEATHER OBS.	X	
46. USE OF CHECK LISTS	X	
47. USE OF RADIO FACILITIES	X	
48. KNOWLEDGE OF PERFORMANCE GRAPHS	X	
FLIGHT CREW—SYSTEMS (NORM. AND EMERG.)		
49. AIR CONDITIONING	X	
50. ANTI-ICE AND DE-ICE	X	
51. ELECTRICAL	X	
52. FIRE PROTECTION	X	
53. FUEL	X	
54. HYDRAULICS	X	
55. PNEUMATICS	X	
56. PRESSURISATION	X	
57. OXYGEN	X	
CABIN CREW		
58. CABIN STAFF PRE-FLIGHT	X	
59. PASSENGER BRIEFING	X	
60. CABIN MANAGEMENT	X	
61. FIRST AID AND EMERGENCY EQUIPMENT	X	
62. EMERGENCY PROCEDURES	X	
AIRPORTS		
63. PUBLIC PROTECTION	X	
64. BRIEFING AND DE-BRIEFING FACILITIES	X	
65. AIR TRAFFIC CONTROL	X	
66. RUNWAYS AND TAXIWAYS	X	
67. LIGHTING	X	
68. RADIO FACILITIES	X	
69. MARSHALLING	X	
70. REFUELLING PROCEDURES	X	

All items marked "UNSAT" must be amplified on reverse side—refer by number.
All items not checked or not applicable must be marked "NA".

FILE

SIGNATURE OF INSPECTOR:	CHECKED:	ACTIONED:
[signature]	[signature] 3/3/77	24/3/77

Initials 24/3/77

DEFICIENCIES (list briefly any remarks to evaluate the flight and crew):

(E-FLIGHT:

A post-flight analysis of the flight plan indicates that the flight was carefully and accurately planned.

PARTURE:

ROUTE: 45 minutes spent over the McMurdo Sound area at FL160. Adequate fuel reserves on departure destination for depressurised return flight to Christchurch. Fuel over Christchurch sufficient for diversion to Auckland with statutory reserves.

OACH AND LANDING:

STRUMENT FLIGHT: Navigation procedures utilising compass switch in DG and using grid navigation well understood by flight crew. No problems whatsoever in navigation. Charting carried on the aircraft adequate for the flight.

LIGHT CREW: Flight crew conservative and conscientious in the conduct of this flight.

ABIN CREW: 6 additional cabin crew carried over the normal establishment for flight time limitations purposes. Rest facilities for cabin crew available on board.

IRPORTS: No adverse radio propagation conditions experienced. Single side band used for communications with McMurdo, Christchurch and South Pole Station. Communications uniformly good throughout with exception of Campbell Island with whom no contact was established.

CTION RECOMMENDED:

CTION TAKEN: The accuracy of navigation was established on the return flight when the NV DME and the inertial navigation system differed by only 3nm after a flight of over 3000nm without a radio update into the ANS.

Nil adverse comments. A well conducted flight in all respects.
See attachments at rear.

US FEDERAL AVIATION REGULATION 91.81

§91.81 Altimeter settings

(a) Each person operating an aircraft shall maintain the cruising altitude or flight level of that aircraft, as the case may be, by reference to an altimeter that is set, when operating -

(1) Below 18,000 feet MSL, to -

(i) The current reported altimeter setting of a station along the route and within 100 nautical miles of the aircraft;

(ii) If there is no station within the area prescribed in subdivision (i) of this subparagraph, the current reported altimeter setting of an appropriate available station; or

(iii) In the case of an aircraft not equipped with a radio, the elevation of the departure airport or an appropriate altimeter setting available before departure; or

(2) At or above 18,000 feet MSL, to 29.92" Hg.

(b) The lowest usable flight level is determined by the atmospheric pressure in the area of operation, as shown in the following table :

Current altimeter setting	Lowest usable flight level
29.92 (or higher)	180
29.91 thru 29.42	185
29.41 thru 28.92	190
28.91 thru 28.42	195
28.41 thru 27.92	200
27.91 thru 27.42	205
27.41 thru 26.92	210

(c) To convert minimum altitude prescribed under §§91.79 and 91.119 to the minimum flight level, the pilot shall take the flight level equivalent of the minimum altitude in feet and add the appropriate number of feet specified below, according to the current reported altimeter setting :

Current altimeter setting	Adjustment factor
29.92 (or higher)	None
29.91 thru 29.42	500 feet
29.41 thru 28.92	1000 feet
28.91 thru 28.42	1500 feet
28.41 thru 27.92	2000 feet
27.91 thru 27.42	2500 feet
27.41 thru 26.92	3000 feet

FIG 1 WRECKAGE OF ZK-NZP LOOKING NORTH OVER LEWIS BAY

FIG 2 LOOKING SOUTHWEST PAST BURNT OUT CABIN TOWARDS MT EREBUS

FIG 3 LOOKING WEST ACROSS WRECKAGE OF ZK-NZP TOWARDS NORTH-WEST SHORE OF LEWIS BAY

FIG 4 AFTERMATH OF INTENSE FIRE IN CABIN AREA

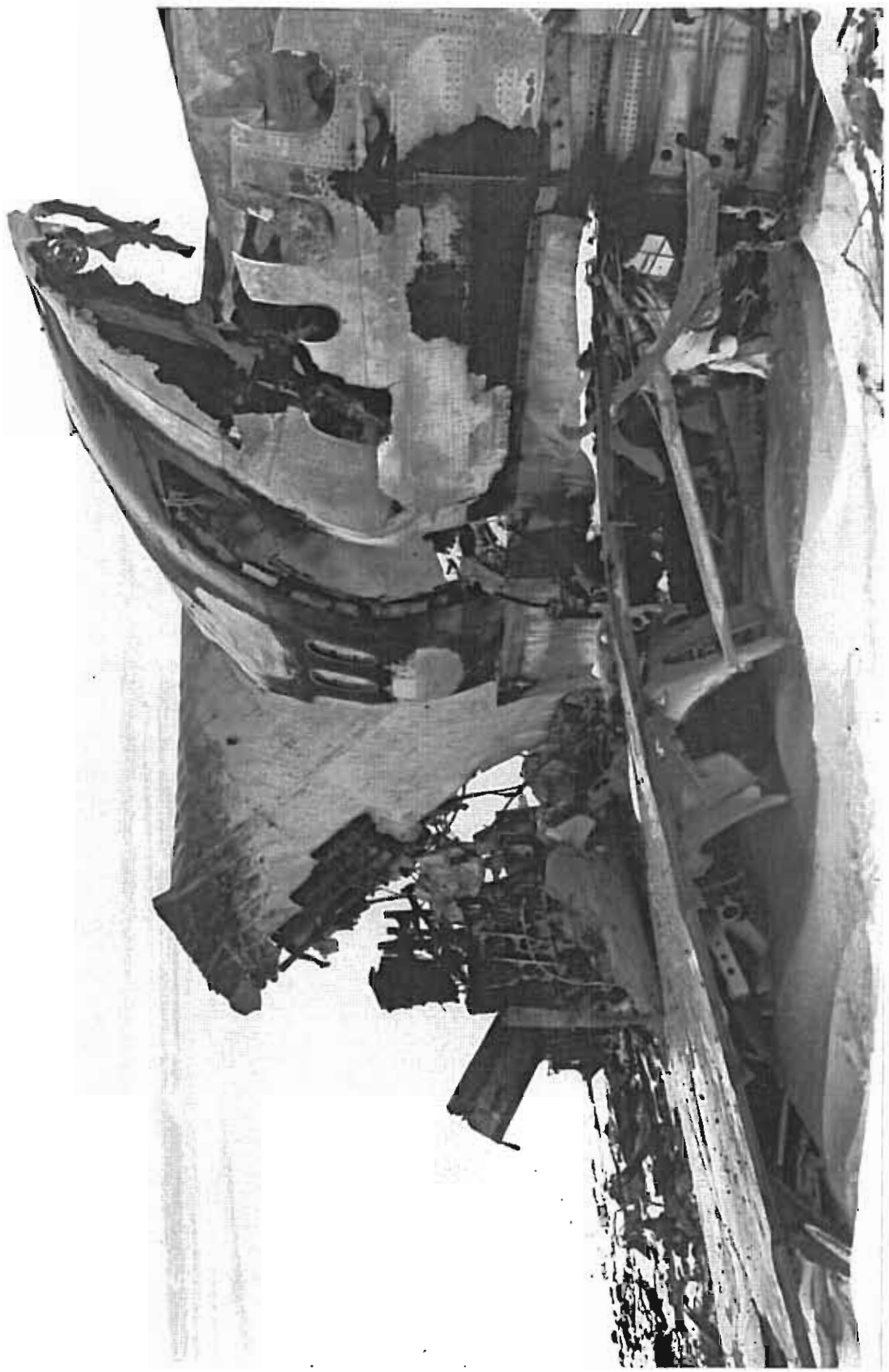


FIG 5 TOP OF RIGHT WING AND RIGHT CABIN SIDE OVER WING DOOR AREA